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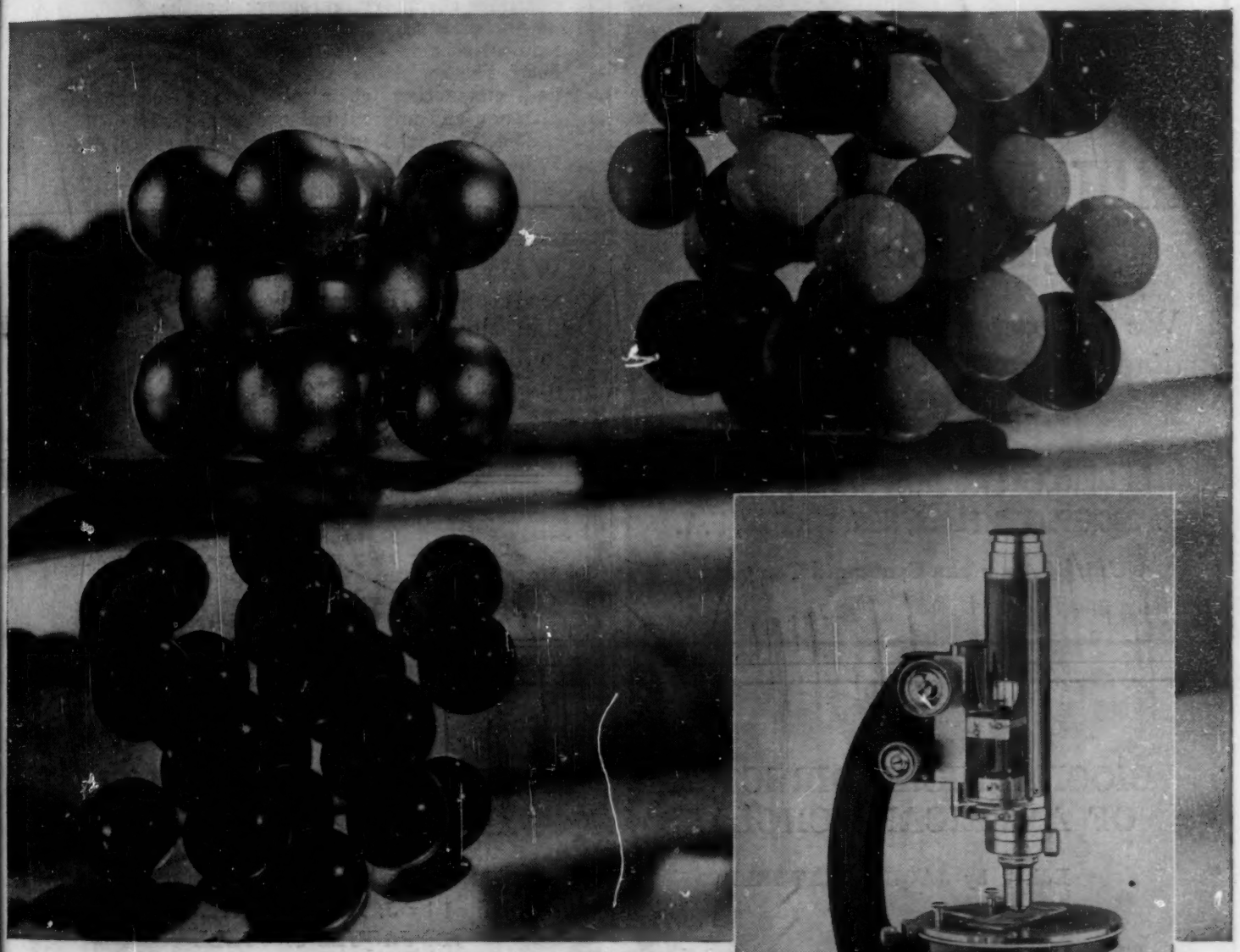

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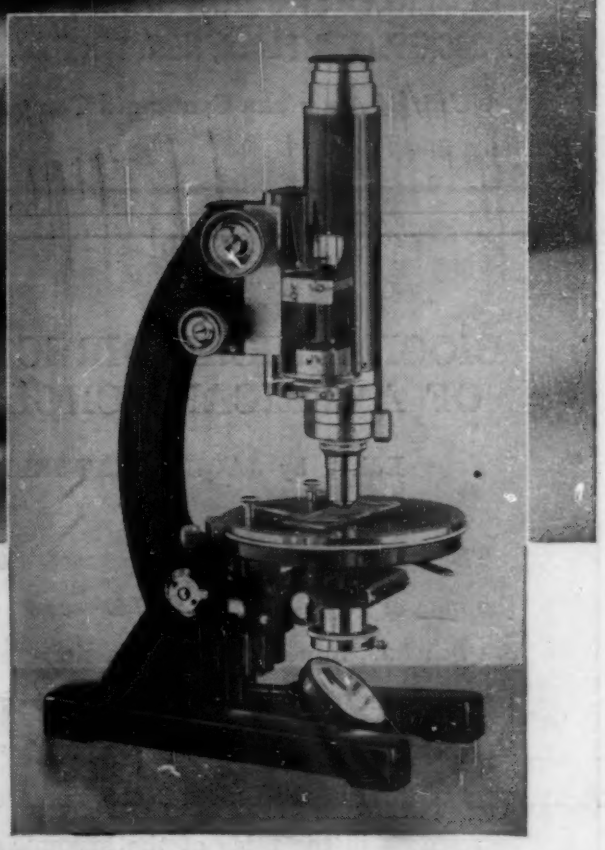

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THE ADVANCEMENT OF SCIENCE IN CHINA DURING THE PAST THIRTY YEARS

By CHUNGSHEE H. LIU

EDITOR, THE *K'o Hsüeh (Science)*, THE SCIENCE SOCIETY OF CHINA, SHANGHAI

I

EVER since the establishment of the Republic of China on October 10, 1911, the development of science in this country has entered a new era of activities in its own history. Unlike the early Ming and the late Ch'ing dynasties,[1] when science was superficially introduced into China, this time we have fostered modern science from quite a different point of view and on a solid foundation. Characteristic features are easily to be noted. Firstly, scientific researches along various branches of science were duly initiated. Original work undertaken at institutes, laboratories and universities made valuable contributions to modern science either of universal nature or of local character. Secondly, since the beginning of this new period, the work of developing science has been entirely entrusted to the Chinese themselves, although a few foreign institutions inherited from the last century were still to be seen in the country, but were not very active. Thirdly, a large number of Chinese scientists, both trained abroad and at home, have served the country in various capacities—in government departments and private institutions. Fourthly, scientific education has received ever so much attention and considerable progress has been observed. Scientific courses were not only taught in schools, colleges and universities, but also gained an important position in their respective curricula. Fifthly, the application of science in various walks of life shows another phase of scientific activities from daily life to national de-

[1] Chungshee H. Liu, *The China Journal*, 34: 3, 120–25; 5, 210–219, 1941.

fense. With the rapid development of science in China, we have every reason to believe that the Chinese people have by now learned how to appreciate the nature of scientific truth and to acquire the technical method. Gradually they become scientifically minded. As a social institution and an academic learning, science has, indeed, steadily taken root in China with bright outlook and hopeful prospects.

Chronologically speaking, the foremost scientific research institution of its kind is undoubtedly the National Geological Survey of China, which was founded in 1916 by the Ministry of Agriculture and Mines at Peiping, then known as Peking. Under its two former distinguished directors, the late Dr. V. K. Ting and Dr. Wen-hao Wong, now China's war-time Minister of Economic Affairs, it has developed into an institution of national importance which attracted world-wide notice in 1929 with the discovery of the "Peking Man," or *Sinanthropus pekinensis*. From the very beginning, the Survey devoted itself to the economic field and undertook nation-wide plans for reconnoitering mineral deposits and carried out geological mapping, including paleontological researches. As a result of the work of a number of young Chinese geologists, many new discoveries were made and proved to be of value to science, not to mention the economic importance. This is best evidenced by the Survey's several serial publications, such as the *Palaeontologia Sinica, Geological Bulletin, Geological Memoirs, Soil Bulletin,* etc. The Survey has also taken up allied responsibility not usually entrusted to geologists. These include seismology, soil survey, fuel research and prehistoric studies; for the last subject the Laboratory for Cenozoic Research was established in 1927 for the purpose. Indeed, during the past twenty-five years this earliest scientific institution of China has made notable contributions to our knowledge of this part of the earth and has established a well-earned reputation in the scientific world.

II

After geology, biological sciences came into the limelight. About twenty years ago, Dr. C. Ping and Dr. H. H. Hu, professors of zoology and botany, respectively, in the Teachers College at Nanking, began to study the fauna and flora of China. Apart from fulfilling their academic duties, they led or planned expeditions from time to time to different regions of the country—from Mongolia and Manchuria in the north to Hainan Island in the south, from the China Seas in the east to the Tibetan Plateau in the west—to collect animal and plant specimens of which many new genera and species, even new families, have been discovered, hitherto unknown to science. By so doing they improved the teaching facilities and paved the way for research on the one hand and trained a large number of young biologists on the other.

In 1922 the Biological Laboratory of the Science Society of China was inaugurated, although the society itself was founded in 1914, the forerunner of its kind in this country. After a hard struggle for several years, the laboratory soon gained recognition of the learned circles of the country, and since 1925 the China Foundation for the Promotion of Education and Culture has made grants to the society for maintaining the activities of the laboratory. Now it has become one of the most important institutions for biological researches in China and is well known to the biological world through its hundreds of exchange publications—*Contributions, Icones* and *Monographs* —with foreign countries the world over. After twenty years of pioneer work, Dr. Ping, the founder of Chinese scientific zoology, still remains as its director and, at the same time, a godfather to many other affiliated institutions.

In 1928, thanks to the moving spirit of Dr. Ping, the China Foundation again helped to establish the Fan Memorial Institute of Biology in Peiping, and he became its first director. Under the experienced guidance for a number of years of Dr. H. H. Hu, the founder of Chinese scientific botany and now president of the National Chiang Kai-shek University, the institute has become one of the best, if not the best, of the scientific organizations of China. It possesses a well-equipped modern building with fine laboratories, a herbarium and a museum of its own. It issues bulletins in two series—zoological and botanical—which have a wide circulation all over the world. It was by this institute that the *Zoölogia Sinica* was published.

Since then, under the joint leadership of Dr. Ping and Dr. Hu, the biological sciences have been enhanced; considerable progress has been made and an enormous amount of work has been done on taxonomy, morphology, physiology, genetics and bio-chemistry, as well as in the economic field. In this connection mention must be made of the Botanical Institute of the National Sun Yat-sen University at Canton, which is devoted entirely to systematic botany with a well-arranged herbarium and good library under the direction of the eminent botanist, Professor Woon Young Chun, whose knowledge of the botany of South China, especially Hainan Island, is second to none in China if not in the world. *Sunyatsenia,* the official organ of the institute, enumerates all the achievements and results of the valuable research work sponsored by the institute. As time went on, there were a number of other biological institutions, such as the Entomological Bureau of Kiangsu, Chekiang, Kiangsi and Kwangtung, the Lushan Arboretum, the Tsingtao Aquarium, the Marine Biological Stations at Amoy and Tsingtao, Oceanographical Survey at Tinghai, Chekiang, etc.

III

But the most important landmark in Chinese scientific research was undoubtedly the establishment of the Academia Sinica, or National Academy of Sciences, soon after the formation of the National Government at Nanking in 1927. According to its charter the Academia Sinica is the highest institution for scientific research in China, designed as a sort of Académie des Sciences, U. S. National Research Council, Department of Scientific and Industrial Research of Great Britain and Kaiser-Wilhelm Gesellschaft combined. Unlike all the other institutions, it is independent of political control, for it does not rank under any ministry or board, but is directly responsible to the national government, which means the President of the Republic. It also functions as the highest national organization for conferring honors upon distinguished scientists and scientific institutions both at home and abroad. For the purpose of directing and coordinating scientific activities in China, there is a council consisting of thirty members, selected from among the scientific workers of the country and a number of *ex-officio* members who have the right to elect candidates for the presidency of the Academia Sinica.

As constituted at present, the Academia Sinica controls ten research institutes, including those of astronomy, meteorology, physics, chemistry, zoology and botany, geology, psychology, engineering, history and philology (including archeology and anthropology), and social sciences. Thus the scope of research is extremely wide; for, on the one hand, it includes such routine service as meteorology, which is usually undertaken by a government bureau; on the other, it embraces history and philology, which are usually considered as belonging to the "humanities," not to say social sciences.

It would be idle to go into details to enumerate the research works carried out by these ten national research institutes. However, a few words on each institute may not be superfluous. In addition to compiling the almanac, supplying time service and determining longitudes and latitudes, the Institute of Astronomy (Professor Y. C. Chang, director), carries out regular photometric and spectrophotometric studies of the sun, the planets and the stars. It also makes observations of variable stars and studies solar activities with the Hale spectrohelioscope. The Institute of Meteorology (Dr. Coching Chu, the pioneer of modern Chinese meteorological research work, director) possesses up-to-date equipment and maintains a seismological station. It has a radiotransmitting station of its own and broadcasts its forecasts daily. The institute keeps in close touch with provincial meteorological stations all over China and those in the Far East. It maintains several branch stations of its own, including one at Chinghai (Kokonor) and another at Lhasa, the capital of Tibet. For upper-air investigations, flights were usually made in cooperation with the National Bureau of Aviation.

The Institute of Physics (Professor H. L. Ting, director) concentrates on researches in wireless, x-rays and geophysical surveying. It maintains a well-equipped workshop for manufacturing scientific instruments, including microscopes, electrical and surveying apparatuses for the use of various schools and scientific institutions. The work carried out by the Institute of Chemistry (Dr. H. C. Woo, acting director) paid more attention to local problems than pure research. Thus, work has been done on Chinese drugs, paper and glass-making, metallurgy of certain rare minerals. The efforts being made by the Institute of Engineering (Jen Chow, director) are on ferrous metallurgy and ceramics with the purpose of better utilization of China's resources in industrialization. Cooperating with the Physics Institute, it maintains standards testing laboratories and thus it fulfils partly the function of a bureau of standards.

The Institute of Geology (Dr. J. S. Lee, an internationally known geologist, director) has four sections: stratigraphy and paleontology, petrography and mineralogy, economic geology, dynamic geology and geophysics. Thus, its work is more on the theoretical side than practical. In cooperation with the National Geological Survey it has also done considerable mapping, especially in the Lower Yangtse Valley. Its publications have also gained international recognition. The Institute of Zoology and Botany (Dr. C. C. Wang, a distinguished young zoologist, director) was originally the Metropolitan Museum of Natural History. It devoted itself exclusively to faunal and floral studies, especially of South and Southwest China. At present, the institute concentrates on taxonomy, economic entomology and plant pathology besides paying special attention to fishery. It took an extensive oceanographic survey in the East China Sea and the Gulf of Chihli. The Institute of Psychology (Mr. G. H. Wong, director) is the smallest and at present its work is largely confined to neural physiology and anatomy.

For "humanities" and social sciences, the Institute of History and Philology (Ssu-nien Fu, director) is quite misnamed, for it is better known by its archeological and anthropological works. For a number of years, it carried out excavation work in Northern China, especially in the Shang capital at Anyang, where discoveries of inscribed bones and shells, bronze, pottery, stone implements and stone carvings belonging to different periods of culture were made. By means of these discoveries, ancient Chinese history, hitherto disputed, is being checked and verified.

Again, the Anthropological Section, under the capable direction of the famous anthropologist and statistician, Dr. T. L. Woo, maintains an excellent anthropometric laboratory and considerable work on measurements, both on the living and on skeletons, has been done. The recently founded *Anthropologia Sinica* is its official organ of publication. Moreover, the Philological and Historical Sections of the same institute have also issued some publications. Like the "humanities" institute, the Institute of Social Sciences (Dr. L. K. Tao, director) had four sections: those of law, economics, sociology and ethnology. However, in 1934, it was amalgamated with the Institute of Social Survey of the China Foundation. Thus reorganized, the new institute devotes itself entirely to economic studies with regard to which some publications have already appeared.

IV

So much for the Academia Sinica. In 1929, another group of research institutes under the Academia Peipinica was organized by the Ministry of Education. This was intended to serve the same purpose as the Academia Sinica, but with a much smaller budget and in different geographical centers. So far, it has maintained six institutes, namely, those of physics, chemistry, zoology, botany, physiology and pharmacology, all of which were located in Peiping except that the Physics Institute (Dr. Ny Tsi-zé, director) has a branch known as the Radium Institute in Shanghai. Like other institutes, they also issue their scientific bulletins.

Other research institutions which deserve mention are the National Agricultural Research Bureau and the National Industrial Research Bureau, both of which are patronized by the Ministry of Economic Affairs. Medical researches are undertaken by the Central Field Health Station, which has done good work on cholera vibrio, the larvacide value of various chemicals, enrichment of soybean milk, the toxicity of habit-forming drugs and the like. It will become the focus of all medical research in connection with public health in China.

Furthermore, some of the scientific institutions under foreign control are worthwhile mentioning in this connection. For instance, the Peiping Medical Union College, supported by the Rockefeller Foundation, has had a considerable influence on Chinese medical research and education, while the Obsérvatoire de Zikawei, Musée Heude, Institute Pasteur de Changhai, the Henry Lester Institute for Medical Research and the Shanghai Science Institute, all located in Shanghai, have done their part in contributing to science.

It is needless to say that research work is also being done in various universities where graduate schools have been steadily organized. In quantity it is naturally less than that of the special research institutions, but its importance is increasing. This shows that a modern Chinese university is organized on just the same plan as those to be found in Western countries and its standing has been raised to a high level. In other words, Chinese scientific education to-day has made considerable progress in comparison with thirty years ago.

Another phase of activities showing the progress of science in China was the flourishing of scientific societies. As mentioned before, the first scientific body ever organized in this country was the Science Society of China, founded in 1914, which is devoted to "the diffusion of scientific spirit and knowledge among the Chinese people, the active participation in scientific research, and the encouragement in their practical application so as to lay a firm foundation for scientific growth and industrial prosperity of the nation as well as contributing to the welfare and progress of the world." For a little more than a quarter of a century, the society has, through its official organ, the *K'o Hsüeh* (*Science*), a semi-technical monthly, made considerable contributions to the promotion of scientific knowledge and cultivation of scientific environment among the people. Before long, the society gained a nation-wide reputation and its members, numbering thousands, are distributed not only throughout the country, but also all over the world.

Other scientific bodies of a general character, such as the Chinese Society of Science and Arts, the Natural Science Society of China and the China Scientification Movement Association, have likewise done some service to the country. Respectively, they have issued *Wissen und Wissenschaft, Scientific World* and *Scientific China* as their official organs.

In addition to the general science organizations, special scientific societies have been formed one after another. As they are too many to enumerate here, we may only mention those whose activities are better known. For pure science, there are the societies of geology, physiology, astronomy, meteorology, physics, chemistry, botany, zoology, geography, mathematics, ethnology, marine biology, etc. All of them have issued their own journals, proceedings or transactions of a high order in Chinese or in European languages. As far as applied science is concerned, there have been no less than 28 societies or associations established belonging to engineering, agricultural and medical sciences. Most of them have their own publications. It is significant that all the above-mentioned societies are purely Chinese in character, although there may be a few foreign members among their members. In order to coordinate scientific activities among various branches of sciences, annual conferences or joint

meetings have taken place year by year and from city to city throughout the country.

V

With regard to the application of science either to the development of industry and agriculture or the welfare of the people, it is obvious that during the past thirty-odd years China has made marvelous advancement in various aspects by the benefit of science. As individual cases are too many to enumerate, we may say in general terms that many modern industrial enterprises have been undertaken on a scientific basis or under scientific management. While heavy industries are still awaiting development in this country, light industries, such as cotton mills, pharmaceutical works, etc., have already made considerable advancement in large cities and seaports like Shanghai, Hankow, Chungking, Canton, Tsingtao and Tientsin. Meanwhile, most of the mining industry has been operated according to scientific methods and management. Scientific agriculture has also been introduced in many fields, such as the improvement of breeding of various crops like cotton, rice and wheat. Reforestation, horticulture and sericulture have also recorded an appreciable improvement.

In the field of engineering sciences, most of the Chinese railways were constructed within the past thirty years, while highways have been rapidly extended during recent years. Scientific hydraulic engineering has replaced the old methods in water conservation works and canaling. Electricity has been employed in various places for different purposes, not only in the telephone and telegram services, but also in a number of ways in the daily life of the people, such as for electric lights, the cinema and the radio. Moreover, machines have been used in numerous ways. In a word, the whole Chinese nation has gradually been transformed from the handicraft stage to a modern machinery age, in so far as the daily life is concerned.

It should be noted, however, that what we have stated in the above paragraphs was merely the advancement of science in China from the beginning of the Republic up to the time when the so-called "China Incident" occurred. During the past four eventful years scientific activities have been speeded up along various fields in the interior provinces. Great efforts are being exerted in biological expeditions, geological surveys, mineral reconnoitering, engineering reconstructions, agricultural improvements, ammunition manufacturing and what not, not to mention laboratory research, with one noble purpose, namely, to meet the wartime need of the nation. The details of these works need not concern us here.

In conclusion, it is no exaggeration to say that during the past thirty years of the Republic, science alone has seen tremendous progress in many sides. Comparing the shortness of time with what has been accomplished, we have at least this feeling of satisfaction that science has become deeply rooted in Chinese soil and our scientists have proved competent for their task in making valuable contributions to modern science and have done good service to the country which was and is urgently needed. The people as a whole have heartily recognized the advantage of the application of science. Therefore, from a historical and scientific point of view, the past thirty years have been a most important and memorable period in Chinese history. With the help of science, we are confident that we shall be able to rejuvenate our nation and reconstruct our country.

OBITUARY

DR. LEONHARD STEJNEGER

October 30, 1851–February 28, 1943

THE stimulating endeavors of Spencer F. Baird, the second secretary of the Smithsonian Institution, attracted not only the naturalists and embryo-naturalists of our own country to this institution of learning, but similarly gifted individuals from abroad came to seek their fortunes at this seat of scientific endeavors. It was Baird's splendid leadership and discernment of men of ability and lack of self-seeking that eventually surrounded him with a staff of scientific men probably unequalled anywhere at any time before. However, this is not intended to be a eulogy of Baird, but a simple appraisal of a great naturalist attracted to our shores by the rapidly spreading fame of the Smithsonian Institution.

Dr. Stejneger was born in Bergen, Norway, on October 30, 1851, the son of Peter Stamer and Ingeborg Catharina (Hess) Stejneger.

From early youth, Stejneger was bitten by the naturalist bug. I have seen a set of his childhood drawings in color of birds of his region which would do credit to an artist of maturer years.

His mother's delicate health requiring a milder winter climate than that afforded by their northland home caused the family to winter in Meran (South Tirol), where we find Stejneger extending his ornithological observations as evidenced by his first published contribution, "Ornithologische Notizen ans Meran, Süd Tirol, wahrend der Winter 1869, 1870, und 70–71."[1] This contribution was followed by a number

[1] *Jour. Ornith.*, pp. 122–124, 1871.

of well-illustrated popular papers on the birds of Norway, and then reports upon birds collected by the Norwegian Mission to Madagascar, the specimens of which were in the Bergen Museum, which yielded him his first new species. All in all, 22 papers had issued from his pen when he left his native land. His interests were not confined to birds, for he was equally well versed in the lore of the other vertebrates, and even invertebrate denizens of land and sea had received more than a passing attention; in other words, he belonged to that group of naturalists whose broad vision at that stage of our knowledge enabled them to have a comprehensive view of the entire zoological field.

It is interesting to note how his educational endeavors, which were not intended to make him a professional naturalist, nevertheless contributed to make him the helpful and outstanding taxonomist and nomenclatorist into which he developed. 1859–60 were spent at the Smith Theological School in Bergen. In 1860–69 he attended Bergen's Latin School. In 1869–70 he was under private tutorship at Meran. In 1870 he entered the University of Christiania as candidate in art, and in 1872 as candidate in philosophy, and finally, in 1875, as candidate in law. Here may be added a Ph.D. *honoris causa* conferred upon him by the same university in 1930.

These studies gave him a splendid command of the classic Greek and Latin and modern languages, and his legal training the outlook which made him a power in questions of nomenclatorial procedure (he served on the International Commission of Zoological Nomenclature from its beginning to his death), while his artistic endeavors furnished that care to detail which has characterized all his work.

Europe with its meager returns to naturalists caused him to look to America as the land of promise, and we therefore find him at the portals of the Smithsonian Institution in the fall of 1881.

Baird, recognizing ability and appreciating Stejneger's knowledge of the Palearctic fauna, saw his opportunity to have the right man in the field to expand our knowledge of the far northwest Pacific fauna and flora. In his usual persuasive way, he showed the U. S. Signal Service how important and necessary it was for it to have an observer on weather in those regions, pointing out that he had just the right man for that job. I fear, however, that the possibility of securing remains of Steller's sea cow and possibly some specimens of Pallas' cormorant (also found to be extinct), to say nothing of the many other things that a young energetic naturalist might secure, may have weighed strongly in having Stejneger appointed observer in the U. S. Signal Service.

Stejneger as U. S. signal observer left Washington on March 22, 1882, arriving on May 7 at Bering Island, where he established a signal station, trained an observer and on June 16 sailed for Petropaulowski, Kamchatka, to establish another signal station. This done, he returned to Bering Island, where he spent the winter. In the fall he circumnavigated Bering Island, visiting the site of the ill-fated Bering Expedition. An interesting account of this trip, well illustrated with sketches and maps, was published in the *Deutsche Geographische Blätter* (Vol. 8, pt. 3, 1885).

In May, 1883, he revisited Petropaulowski, and in the summer went to Copper Island to study the habits of the fur-seals whose large rookeries were being exploited by the Alaska Commercial Company. He then returned to Bering Island, from where upon the completion of his work he returned to the United States, arriving at the Smithsonian Institution on October 29, 1883.

The Annual Report of the Board of Regents of the Smithsonian Institution for 1883 (1885) gives a fine account of the splendid results of this expedition, which must have given great pleasure to Secretary Baird as well as to the collector.

In 1884 we find him as assistant curator, Department of Birds, U. S. National Museum, busy upon a general account of his northern expedition and sundry other papers, foremost among which were his "Results of Ornithological Explorations in the Commander Islands and in Kamchatka[2] and Volume 4, "Birds" of the Standard Natural History, published by S. E. Casino and Company in 1885.

Overwork carried the usual syndrome of manifestations and resulted in Stejneger being sent to Arizona to join Dr. C. Hart Merriam, who was making his studies of the life zones of the San Francisco Mountains.

His stay there resulted not only in the recovery of his health, but also in the securing of a mass of information in the field that was to embrace his major attention during the rest of his days—herpetology—for Stejneger was appointed curator of reptiles of the U. S. National Museum on March 1, 1889.

In 1895 Dr. Stejneger was detailed to the U. S. Fish Commission as attaché to revisit the Russian Fur-Seal Islands and report on the existing conditions of their herds. He accordingly left Washington on May 28. He reached St. Paul Island (Pribilof group) on June 25, where a special seal drive was arranged for him next day to acquaint him with local killing methods; the next day he left for Bering Island, which he reached on July 3. From this date to September 24 his time was spent in gathering data and photographing the herds of Bering and Copper Islands, the

[2] *Bull. U. S. National Museum*, 29: 1–382, pls. i–viii, 1885.

results of which were embodied in his exhaustive report on "The Russian Fur-Seal Islands.[3]

This masterful treatise made him a marked man in fur-seal matters. It is therefore not surprising that, when Congress ordered "a scientific investigation during the years of 1906 and 1907 of the present conditions of the fur-seal herds on the Pribilofs, Commander and Kuril Islands in the north Pacific and Bering Sea," Stejneger by Presidential order was called to take part in these investigations.

We therefore again find him on the Russian fur-seal islands, as well as on the Japanese Robben Islands in the Okhotsk Sea in 1896 and 1897. His major contribution to the reports of the commission are contained in Part IV, "The Asiatic Fur-Seal Islands and Fur-Seal Industry."[4]

His last visit to the northern isles was made in 1922 when the Department of Commerce requested his detail to assist in obtaining exact information on the status of the fur-seal herds on the Russian and Japanese seal islands, in order to determine the effect of the treaty of 1911 entered into by the United States, Russia, Japan and Great Britain for the protection of the fur-seals of the north Pacific Ocean.

His report is contained in "Fur-Seal Industry of the Commander Islands."[5]

Here, as the culminating effort of his northern explorations, should be mentioned his volume on "Georg Wilhelm Steller, the Pioneer of Alaskan Natural History."[6] The fascinating account of this naturalist was inspired by Stejneger's first visit to Bering Island. From that time on he lost no opportunity to trail this man from birth to death, by the search for information from relatives, church records, official documents, museum specimens and the maze of publications resulting from the collections and notes made by Steller. All this information Stejneger has woven into a reconstruction of the conditions of the times and the environment, both human and otherwise, with its trials, tribulations, hardships and joys under which this energetic and able naturalist accomplished remarkable results.

Stejneger's first love, like that of many other naturalists, was birds. We therefore find his early contributions dealing with avian topics. After his appointment to the curatorship of reptiles there is a rapid transition in his writings to the herpetological field. His first reptile paper, "Description of Two New Species of Snakes from California," was published in the Proceedings of the U. S. National Museum, Vol. 12, pp. 95–99, October, 1889.

1895 saw the issuance of his "Poisonous Snakes of North America."[7]

Our acquisition of Puerto Rico following the Spanish-American War inspired our government to explore its resources, which resulted, among other endeavors, in a visit by Dr. Stejneger to that island to study its herpetologic treasures. February 12 to April 19, 1900, was devoted to collecting in the islands of Puerto Rico and Vieques. The results of this expedition are embodied in "The Herpetology of Puerto Rico."[8]

His next comprehensive efforts are embraced in his "Herpetology of Japan and Adjacent Territory."[9] In 1917, in collaboration with Thomas Barbour, he published "A Checklist of North American Amphibia and Reptiles,"[10] of which the fifth edition is now going through press. A timely and interesting account, "A Chapter in the History of Zoological Nomenclature,"[11] appeared in 1924.

An examination of Dr. Stejneger's bibliography reveals a total of 411 titles, of which 152 pertain to herpetology, while 146 deal with birds, 30 with explorations and 16 are devoted to mammals and the rest scattering.

In 1911 Stejneger was appointed head curator of biology, U. S. National Museum.

Stejneger attended eight International Zoological Congresses, seven of them as delegate of the Smithsonian Institution: 4th Cambridge, 1898; 5th Berlin, 1901; 6th Berne, 1904; 7th Boston, 1907; 9th Monaco, 1913; 10th Budapest, 1927; 11th Padua, 1930, and 12th Lisbon, 1935.

In 1898 he spent four and one-half months in Europe studying museums and specimens and also attended the International Fisheries Exposition at Bergen, Norway. In 1905 he was a delegate of the Smithsonian Institution at the Fourth International Ornithological Congress in London and the Internal Convention of the International Catalogue of Scientific Literature. In 1907 he was a delegate of the U. S. National Museum at the International Fisheries Congress at Washington. In 1911 he represented the Smithsonian Institution at the five hundredth anniversary of the founding of the University of St. Andrews, Scotland. In 1911 he represented the

[3] *Bull. U. S. Fish Comm.*, art. 1, pp. 1–148, pls. 1–66, 1896.

[4] "The Fur-Seals and Fur-Seal Islands of the North Pacific," Pt. 4, pp. 1–384, pls. 1–117 and maps. Government. Washington. 1898.

[5] *Bull. Bur. Fish.*, 41: 287–332, figs. 1–17, 1925.

[6] Harvard University Press, pp. i–xxiv; 1–623, pls. 1–30, 1936.

[7] Report of the U. S. National Museum for 1893, pp. 337–487, pls. 1–19, 70 text figures, 1895.

[8] Annual Report of the U. S. National Museum for 1902, pp. 549–724, pl. 1, figs. 1–197, 1904.

[9] *Bull.* 48, U. S. National Museum, pp. 1–44–1–577, pls. 1–35, 409 text figures, 1907.

[10] Harvard University Press, pp. i–iv, 1–125, 1917; 2d ed., 1923, pp. i–x, 176; 3d ed., 1933, pp. i–xiv; 1–185; 4th ed., 1939, pp. i–xvi; 1–207; 5th ed. In press.

[11] *Smithsonian Misc. Coll.*, Vol. 77, no. 1, pp. 1–21, 1924.

Smithsonian Institution at the one hundredth anniversary of the founding of the Royal Frederic University in Christiania, Norway. In 1912 he represented the U. S. National Museum at the centenary celebration of the founding of the Academy of Natural Sciences, Philadelphia. In 1935 he was a delegate to the sixth International Congress of Entomology at Madrid, Spain. In 1939 he was delegated by the Smithsonian Institution to attend the two hundredth anniversary of the Royal Swedish Academy of Sciences (celebration cancelled) and to attend to official business of the Smithsonian Institution and the U. S. National Museum in Sweden, Norway, Denmark and Finland.

Stejneger was a member of many scientific societies at home and abroad, among which may be mentioned: National Academy of Sciences; American Ornithological Union (fellow); American Society of Ichthyology and Herpetology (vice president, 1915; president, 1919; honorary president, 1937); American Society of Mammalogists; American Association for the Advancement of Science; Washington Academy of Sciences; Biological Society of Washington (president, 1907–08); the Academy of Natural Sciences of Philadelphia; Association of American Geographers; California Academy of Sciences (honorary member); Bergen Museum (life member); Christiania Academy of Sciences; Zoological Society of London (foreign member); Ornithological Society of Bavaria (corresponding member); British Ornithological Union (honorary member); German Ornithological Society; Peiping Natural History, etc. He was a member of the Cosmos Club.

Dr. Stejneger was decorated Knight, 1st class, Royal Norwegian Order of St. Olof in 1906 and Commander in 1939. He was also the recipient of the Walker Grand Prize of the Boston Society of Natural History.

On his eighty-fifth birthday the Smithsonian Institution was presented with a portrait of Dr. Stejneger, painted by Bjorn P. Egeli, purchased by subscriptions made by his associates and friends. On his eighty-sixth birthday Dr. Stejneger was tendered a sumptuous dinner by his associates and friends at the Cosmos Club. Dr. C. G. Abbot, presiding, called upon the following to respond to these toasts: Stejneger, the Youth—His Excellency Wilhelm Munthe Morgenstierne; Stejneger as an Ornithologist—Dr. Alexander Wetmore; Stejneger as a Herpetologist—Professor Albert Hazen Wright; Stejneger as a Zoogeographer—Dr. William Mann; Stejneger as a Nomenclatorist—Dr. Charles Wardell Stiles; Stejneger as a Man—Dr. Albert Kenrick Fisher. These were followed by a response from Dr. Stejneger. On this occasion there was presented to Dr. Stejneger a huge volume of letters expressing felicitations and appreciation written by scientific friends from all corners of the world.

Having been in almost daily contact with Stejneger since 1896, officially and unofficially, I can say that he was an ideal personification of the scientific spirit—a seeker of truth—ever open-minded, without pet theories, whose every study was a problem, the answer the summation of all the counts.

It was interesting to note the change of the man from a rather positive and somewhat aggressive disposition in youth to that of extreme tolerance and patience, particularly with the younger naturalists to whom he was ever willing to lend a helping hand. He was an ideal friend and host and the portals of his house were ever open to his friends from home or abroad. Stejneger was married to Marie Reiners on March 22, 1892, who, with his daughter Inga, survives him.

PAUL BARTSCH

U. S. NATIONAL MUSEUM

DEATHS AND MEMORIALS

DR. FRANK SCHLESINGER, professor emeritus of astronomy of Yale University, from 1920 to 1941 director of the observatory, died on July 10 at the age of seventy-two years.

DR. LESLIE TILLOTSON WEBSTER, member of the Rockefeller Institute for Medical Research, died on July 12 in his forty-ninth year.

DR. WILLIAM JAMES FOSTER, assistant engineer of the alternating current engineering department of the General Electric Company, died on July 2 at the age of seventy-two years. Dr. Foster joined the General Electric Company in 1894 and became an assistant engineer in 1906. He was associated in his work with the late Dr. Charles P. Steinmetz.

BAYARD H. CHRISTY, former president of the Pittsburgh Patent Bar Association, died on June 20 at the age of seventy-one years. He was a life member of the American Ornithologists' Union and the author of numerous papers on birds in ornithological journals.

ARRANGEMENTS have been completed, according to a report in *Chemical and Engineering News*, for the establishment of a foundation in memory of the late Dean Herman Schneider. The Herman Schneider Foundation has been incorporated in Ohio "to encourage the development and advancement of science and education." A building has been purchased and will be ready for occupancy in the fall as headquarters

for the engineers and scientists of Cincinnati. There will be an auditorium seating 300, a smaller meeting room for about 100, several committee rooms, a large library, reading rooms, reception rooms, office and recreation space, with possibilities of kitchen and dining-room facilities.

SCIENTIFIC EVENTS

THE BIRTHRATE OF GREAT BRITAIN

COMMENTING on a debate before the British House of Lords opened by Lord De La Warr and participated in by Lord Nathan, Viscount Samuel, Lord Geddes, Viscount Dawson of Penn and the Duke of Devonshire, *The Times*, London, on June 19 writes editorially as follows:

Lord De La Warr yesterday performed a useful service in the House of Lords by once again drawing attention to the implications of the decline of the birthrate; for the numbers and age composition of the population are, as he said, "the very basis" on which all plans of reconstruction must rest. The significance of present population trends is brought out by a comparison of the position in the 1930's, when there were over 41,000,000 people in England and Wales, with the position in the 1850's, when there were 18,000,000 people. To-day there are just under 10,000,000 women capable of bearing children, compared with only 2,250,000 in 1851. Yet in the ten years 1933–42 590,000 fewer babies were born in England and Wales than in the ten years 1851–60. The reduction of infant mortality since the middle of the last century has greatly improved a baby's chances of survival. Nevertheless there are scarcely more children under fifteen than in the early 1870's, and 2,250,000 fewer children to-day than just before the last war. In fact Britain, in peace as in war, is now living on human capital accumulated in a more fertile past. British mothers and fathers in the twenty years before the last war, although somewhat less fertile than their Victorian ancestors, produced a greater number of children than were born in any period of similar length previously or subsequently. Those children are the young and middle-aged adults of to-day. This generation of potential parents is of record size; and upon them falls the responsibility of bearing and rearing the children of the coming generation. Yet, although they show no aversion from marriage, such is their apparent aversion from parenthood that, if present trends continue, the succeeding generation will fall at least 20 per cent. short in numbers.

At the same time the present generation of potential parents will, in the next thirty years, grow into a generation of old-age pensioners. The proportion of old people over 64 in the total population has doubled itself in the past ninety years; it may well double itself again in the next thirty years. The present generation of adults under 40 is building up for itself far larger claims on the national income for its old age—in the form of pension rights—than any previous generation, and simultaneously it is failing to produce the workers who will have to maintain it in its years of retirement to a far greater extent than any previous generation. In the last analysis the aging of our population—with all that it implies in politics and social life, in economic policy and in imperial and international affairs—is a far more serious issue than the total size of the population. It is the fundamental long-term problem which Britain—in common with all the peoples of Northern and Western Europe—will have to face. Ultimately Britain must have a population policy conducive to social views and social conditions which favor parenthood instead of frustrating it. There can be no question of waiting twenty or thirty years for such a policy. The consequences are certain and action can not be postponed.

Little, however, is yet known about the economics of family life, or about the ways in which, in different income and social groups and in families of different size, parents spend their money on children. Practically nothing is known about current attitudes to parenthood, about the reasons why childbearing is increasingly avoided, or about the whole complex of economic, social and psychological factors which now apparently frustrate parenthood but might be transformed in a cultural and material environment favorable to family life. On all these issues there are many opinions, but a startling lack of factual knowledge. Even although large-scale reforms to encourage parenthood must inevitably wait until victory has been won, there remains an immense task of basic fact-finding investigations, which should be begun without delay. A Royal Commission, suggested by Lord Geddes, may not be the most appropriate instrument for this work. But, however undertaken, there is a strong case for putting it in hand at the earliest moment.

THE BOTANIC GARDEN OF THE UNIVERSITY OF CAMBRIDGE

THE University of Cambridge correspondent of *The Times*, London, gives the following account of the history of the Botanic Garden of the University of Cambridge in connection with the large bequest to the garden received from the estate of Reginald Cory.

After several abortive attempts to found a physic garden in Cambridge University in the sixteenth and seventeenth centuries the first botanic garden was established in 1762, through the generosity of Dr. Walker, then vice-master of Trinity College, on a site five acres in extent now occupied by laboratories on the north side of Downing Street. Until a few years ago one of the trees originally planted, a fine specimen of *Sophora japonica*, still existed there.

Early in the nineteenth century the garden fell into neglect and, being in a confined space in the middle of the town, it became unsuitable for its purpose. In 1831 the university bought 40 acres of land along the Trumpington Road, on the outskirts of the town, for the site of a new botanic garden, which was officially

opened in 1846. Great care was taken in laying it out, and owing to its proximity to Hobson's Conduit a large pond stream and bog garden could be established. Interesting trees and shrubs in great variety were planted at an early date; these now beautify the garden and some of them are among the best specimens in the country.

In 1888–91 a new range of glasshouses was erected. These were reconstructed in teak in 1933–34, largely through the generosity of W. J. Courtauld. They now house a fine collection of exotic plants, ranging from succulents to tropical orchids, from palms to tree ferns. In recent years the garden has been fortunate in its curators and superintendents, men of great horticultural skill who have devoted themselves to increasing its beauty and botanical interest. By hybridization they have produced many well-known ornamental plants which are now widely grown, notably the roses *Rosa Cantabridgiensis* and *Rosa Coryana,* gerberas, cinerarias (including "Beauty of Cambridge"), *Columnea Banksii* and *Bomarea Cantabridgiensis.* The garden is an integral part of the university department of botany, and all the botanical staff, as well as the director of the garden, take a great interest in its welfare. It has a deservedly high reputation, and there are now great possibilities of further enhancement.

Many private benefactors have assisted in a most generous way, but there has now begun to accrue the greatest benefaction of all. Reginald Cory, a graduate of Trinity College and a great gardener, took much interest in the garden and handsomely contributed to its funds during his lifetime. When he died in 1934 he bequeathed the residue of his estate to it, with the result that from now onwards it will receive an additional £9,000, rising eventually to £13,000, a year.

In accordance with the terms of the will only £1,000 a year of the benefaction can be devoted to maintenance, the remainder being available for capital expenditure, including the purchase of land for extension. With this very large bequest it should be possible in the course of time to make the Cambridge Botanic Garden one of the best in the world as regards both the variety of plants cultivated in it and general beauty.

With the opportunities now offered, several branches of botany will inevitably be greatly assisted. In the past many important botanical investigations have been carried out at the garden, notably the pioneer researches in plant genetics by the late W. Bateson, Miss E. R. Saunders and Professor R. C. Punnett. From the time of its establishment its facilities have been extensively used by the staff of the department of botany for their investigations.

When, in 1934, the syndicate announced that Mr. Cory had bequeathed the residue of his estate to the university for the benefit of the garden, it was not known that a great sum would result, and it seemed clear that no money was to be expected from this source for many years to come. But the trustees have recently been able to sell certain shares in the family business to advantage, and though at present expenditure on maintenance is inconveniently limited, the university is the recipient of the largest bequest in its history, and Reginald Cory's name will stand high in its list of benefactors.

RECOMMENDATIONS FOR THE CARE OF THE MEDICALLY INDIGENT

A SERIES of recommendations relative to a plan for the medically indigent has been formulated by the Committee on Medical Economics of the Medical Society of the County of New York, and was adopted by the Comitia Minora at its last meeting.

The report of the committee and its recommendations are as follows:

(1) A central municipal registration bureau must be established.

(2) A non-governmental, non-profit agency or corporation is to be set up with the cooperation of the city government, the Board of Directors to consist of one third city officials, one third physicians selected or appointed by the five County Medical Societies of Greater New York and one third prominent laymen acceptable both to physicians and government representatives. The medical members shall constitute the Medical Policy Committee. There shall be no change in medical policy without the consent of the Medical Policy Committee.

(3) The premium charged shall be approximately such that the physician shall receive $2.00 per house visit and $1.00 per office visit. This may be adjusted at the discretion of the Policy Committee.

(4) A panel shall be established and patients in their districts shall consult them. The city shall be zoned in order to prevent physicians from having to travel too far to see these patients and *vice versa.*

(5) All licensed doctors of medicine may register on the panel.

(6) In carrying out the plan, it is apparent that the occasion may arise when it may become necessary to have a specialist's opinion. Fee for this service in the home will be set up with due regard to the costs and solvency of the plan. No physician can be on a panel and at the same time serve as a specialist or special consultant.

(7) Physicians taking care of these patients shall be permitted to have diagnostic tests in the clinics without charge and without the patient becoming a member of the clinic. Some charge is to be made for these tests to prevent too many of them being done.

(8) Medical indigency rates: $1,000 for single persons; $1,450 man and wife; $250 allowance for each dependent (not to exceed $1,950 per family). This may be

adjusted at the discretion of the Policy Committee. A certificate of registration shall be required for each year.

(9) There shall be a paid physician who shall be chief executive.

(10) The best interest of the patient and the solvency of the plan will consider that the hours for receiving panel calls shall be from 8 A.M. to 8 P.M., except in case of emergency. Calls after these hours shall entail an additional fee at the expense of the patient. The amount of extra compensation to be determined by the Policy Committee.

(11) On due notice, physicians shall have the right to refuse these patients and the patient may change physician if he desires. The physicians involved shall pro-rate the fee.

(12) Since it is recognized that individuals on relief are the responsibility of the city, it is apparent that the plan must be reimbursed for services rendered to individuals on relief if and when the recipient is unable to pay in full or in part for the services rendered.

NEW AND RARE INSTRUMENTS

THE Committee on Location of New and Rare Instruments has the following requests and offers:

Instruments Offered

L. & N. thermionic amplifier
Ammeters—Whitney and Jewel
Various balances
Schmidt & Haensch colorimeter
Platinum calorimeter
Weston D.C. electric meters, voltmeters, ammeters, galvanometers
Spindler and Hoyer electroscope
Two-circle Goniometer (to loan for war use)
Microscopes—Bausch and Lomb centrifuge, Zeiss binocular, Leitz (suitable for photomicrography), Poeller
Optical wedge pyrometer
4 L. & N. portable potentiometers
L. & N. Type K potentiometers
Polarizer and analyzer for microscope
Abbe refractometer
R. Fuess reflectometer
Spectrographs, spectroscopes, spectrophotometers
Saccharimeters
Saybolt Universal Viscosimeter

Instruments Requested

Western Electric electrometer
Flexaform set
Amsler No. 4 integrater
Micromanipulators

Information concerning these offers and requests for rare instruments that can be sold, loaned or leased for essential war research work can be obtained from D. H. Killeffer, chairman of the committee, 60 East 42nd Street, New York 17, N. Y.

THE VIRGINIA ACADEMY OF SCIENCE RESEARCH ENDOWMENT

FOR some years the Virginia Academy of Science has had an endowment fund of about $12,000, which was raised by Dr. J. Shelton Horsley as a research fund when he was president in 1926–27. This fund is administered by a research committee which awards a prize of $50 each year for a meritorious paper read at the meeting, and makes grants in aid of research.

Some months ago, Dr. Gillie A. Larew, of Randolph-Macon Woman's College, who has been a valued member of this committee for some years, was asked to write a short account of its work for the *Alumnae Magazine* of her college. She did so and shortly thereafter was surprised to learn that Mr. and Mrs. C. M. Goethe, of Sacramento, Calif., on reading her account, became so much interested in the work of the committee and its need of greater funds that they generously agreed to offer to contribute $200 a year ($100 each) so long as they conveniently could, provided the academy would raise an additional $400 on similar terms.

At the recent meeting in Richmond, the academy completed the raising of the required $400. Not only were the required pledges obtained, but well over $400 has already been deposited in the bank and checks and cash are in hand that will bring the total to $439. This additional $600 will about double the amount of money available to the committee each year and will make possible some modifications and enlargements of their present policies.

This is directly in line with the policy of the American Association for the Advancement of Science in encouraging research work through its affiliated state academies of science. For several years now it has fostered, encouraged and directed them through the academy conference and has allotted them money for research purposes.

SCIENTIFIC NOTES AND NEWS

THE Marcellus Hartley Public Welfare Medal and Certificate of the National Academy of Sciences was presented on June 14 to John D. Rockefeller, Jr.

THE Society of Chemical Industry has awarded the Chemical Industry Medal for 1943 to Dr. John J. Grebe, director of the Physical Research Laboratory at the Dow Chemical Company, Midland, Mich. The presentation will be made next November.

THE appointment of Dr. Boris Petrovitch Uvarov, of the Imperial Institute of Entomology, as an Hon. Companion of St. Michael and St. George for valuable services in connection with anti-locust measures,

is reported in *The Times*, London. Dr. Uvarov has been on the staff of the Imperial Institute of Entomology since 1920 and is at present the technical adviser of the anti-locust campaign which is being carried on throughout North Africa and the Middle East.

DR. WESTON A. PRICE will be honored by the Cleveland Dental Society with a testimonial dinner on Thursday evening, October 7, at the Hotel Statler in Cleveland. After fifty years of active practice in Cleveland, Dr. Price plans to go to California to continue his investigations on the influence of diet on dental diseases.

OFFICERS for 1943–44 of the American Society of Plant Physiologists have been elected as follows: *President,* B. S. Meyer, of the Ohio State University; *Vice-president,* Paul J. Kramer, of Duke University, and *Secretary-treasurer,* Earl S. Johnston, of the Smithsonian Institution of Washington.

THE following officers of the American Rocket Society, 130 West 42nd Street, New York City, have been elected for the coming year: *President,* Cedric Giles; *Vice-president,* Constantine Lent; *Secretary,* J. H. Wyld, and *Treasurer,* Dr. Samuel Lichtenstein.

AT the last regular meeting of the Society of Sigma Xi at the University of Oklahoma, Dr. Charles E. Decker was elected president; Dr. Richard L. Huntington, vice-president, and Dr. Leslie Hewes, secretary-treasurer. A celebration of the four-hundredth anniversary of the death of Copernicus was sponsored by the society on June 29.

HONORARY professorships at Columbia University have been awarded as follows: Dr. William K. Gregory, who has been on the staff since 1925 and has been associated with the American Museum of Natural History since 1911, has been named DaCosta professor of vertebrate paleontology. Dr. William Duncan Strong, professor of anthropology, has received the title of Loubat professor of American anthropology. Professor Douglas Johnson, since 1937 executive head of the departments of geology and mineralogy, has been given the title of Newberry professor of geology.

RONALD AYLMER FISHER, F.R.S., professor of eugenics at University College, London, has been elected to the Balfour professorship of genetics of the University of Cambridge, the appointment to take effect on October 1.

DR. T. SHIRLEY HELE, master of Emmanuel College and representative of the University of Cambridge on the General Medical Council, has been elected vice-chancellor of the university for the ensuing academic year.

VARD M. SHEPARD, who had been temporarily assigned to the Emergency Farm Labor program, has been appointed to the post of extension specialist in animal husbandry at the University of California at Berkeley.

DR. JAMES A. ADAMS, formerly assistant professor of zoology at Grinnell College, has been appointed assistant professor in entomology at the New York State Experiment Station at Geneva, N. Y. For the present, he will devote his attention to studies on the biological control of the Japanese beetle.

THE appointment is announced of Dr. Reginald C. Sherwood, food chemist of St. Paul, Minn., as assistant chief to Dr. Russell M. Wilder in the civilian food requirements branch of the Food Distribution Administration of the Department of Agriculture in Washington, D. C.

DR. JAMES M. SCHOPF has succeeded George M. Sprunk in the microscopical laboratory of the U. S. Bureau of Mines in Pittsburgh. He will continue studies on the origin and constitution of coal varieties that were originally instituted by Reinhardt Thiessen.

DR. VICTOR E. JOHNSON, associate professor of physiology and dean of students in the division of biological sciences of the University of Chicago, on July 1 became secretary of the Council on Medical Education and Hospitals of the American Medical Association. Dr. Basil C. H. Harvey, who retired in September, 1940, after thirty-eight years as a member of the faculty, will return to active duty as acting dean.

BRIGADIER GENERAL JAMES STEVENS SIMMONS, director of the Preventive Medicine Division, Office of the Surgeon General, U. S. Army, was appointed on May 27 by the Board of Overseers of Harvard College a member of the visiting committee for the Harvard School of Public Health.

SIR LAWRENCE BRAGG, Cavendish professor of experimental physics at the University of Cambridge, and Dr. C. G. Douglas, professor of general metabolism at the University of Oxford, have joined the council of the British Gas Research Board.

DR. FRANK WILCOXON, of the Atlas Powder Company, has become group leader in charge of the Insecticide and Fungicide Laboratory of the Stamford, Conn., Research Laboratory of the American Cyanamid Company.

DR. L. M. CLINE, assistant professor of geology at Iowa State College, has resigned to join the Standard Oil Company of Texas, and Dr. N. E. Fabricius, assistant professor of dairy industry at the college, will join the Golden State Company of San Francisco.

DR. SHERWIN F. WOOD, of La Crescenta, Calif., instructor in the department of life sciences at Los Angeles City College, has recently been commissioned a lieutenant (j.g.) in the U. S. Naval Reserves. He is now in training as a malariologist at the National Naval Medical Center in Bethesda, Md.

DR. REGINALD D. MANWELL, professor of zoology in Syracuse University, has been commissioned First Lieutenant in the Sanitary Corps, and has been assigned to Tilton General Hospital, Fort Dix, N. J., for temporary duty.

RESEARCH projects on quinine and other alkaloids of *Cinchona* are announced as follows: Cornell University Medical College, "The action of Cinchona alkaloids on experimental infections," under the direction of Dr. Harry Gold and Dr. McKeen Cattell; New York University, a threefold investigation on (a) "Quantitative study of intestinal absorption and subsequent distribution of the alkaloids between blood, brain and body fluids," (b) "Mode of action on myoneural systems and micro-organisms" and (c) "Action of the alkaloids on isolated enzyme systems," under the direction of Dr. Dugald Brown; the Johns Hopkins University, "A study of quinine and malaria in the Upper Mississippi Valley," by Dr. Erwin H. Ackerknecht, under Dr. Henry E. Sigerist, of the Institute of the History of Medicine; Battelle Memorial Institute, "A preliminary study of the industrial uses of *Cinchona* alkaloids," under the direction of Dr. M. M. Baldwin and Dr. Frank C. Croxton. All the investigations are sponsored by the Cinchona Products Institute, New York, which also announces the availability of two research fellowships for accredited workers in this field.

THE *Journal* of the American Medical Association states that the National Research Council recently sponsored the visit of a group of investigators to the Nutrition Clinic at the Hillman Hospital, Birmingham, Ala., to study the work of Dr. Tom D. Spies with a view to determining the possibility of extending corn meal to meet special nutritional needs of the South. The visit, it is said, was financed by private contributions and by the Research Council. Among the group were Dr. Russell M. Wilder, Washington, D. C.; Dr. William H. Sebrell, Jr., Bethesda, Md.; Dr. Robert F. Griggs, Elmer M. Nelson and Dr. Frank L. Gunderson, Washington; Dr. Charles G. King and Dr. Robert R. Williams, New York, and Dr. James S. McLester, Birmingham.

A SERIES of lectures on tropical diseases was recently given by Captain Paul W. Wilson, of the Medical Corps of the U. S. Navy, at the Mayo Foundation, Rochester, Minn.

DR. FREDERICK C. LEONARD, chairman of the department of astronomy of the University of California at Los Angeles, on May 26 addressed the student body of George Pepperdine College, Los Angeles, on "Copernicus and the Foundations of Modern Astronomy."

PROFESSOR C. L. METCALF, head of the department of entomology, University of Illinois, has completed a fifteen weeks' series of lectures to the officers at Chanute Field, Rantoul, Ill., on medical entomology and insect control.

IN view of the need for pathologic material in undergraduate and graduate education, the Committee on Pathology of the National Research Council urges that all who have suitable anatomic specimens forward them to the curator of the Army Medical Museum, Washington, D. C., for correlation and distribution to other central agencies and to teaching institutions. Material from the following is particularly wanted: the malarial diseases, bacillary dysentery, endamebiasis, the schistosomiases, filariasis, the trypanosomiases, the relapsing fevers, the leishmaniases, the rickettsial diseases, yellow fever, cholera, plague and yaws. On application to the curator, arrangements for transportation will be made.

THE *Experiment Station Record* reports that the Kansas legislature has appropriated $2,653,000 for the support of Kansas College and four branch stations during the biennium that began on July 1. In addition to lump sum appropriations for salaries and maintenance for instruction and research, the total includes $102,000 for the four branch stations, $52,000 for outlying experimental fields, $10,000 for bindweed experimental work, $30,000 for research work on diseases of livestock, $15,000 for milling and baking research, $20,000 for laboratory equipment, $200,000 for extension work and $60,000 for a 16-week wartime summer session. This total also includes $64,500 for the completion of a military science building, $50,000 for a small animal laboratory building and $12,500 for repairs on the power plant. President F. D. Farrell retired on July 1 to become president emeritus. He will be succeeded by M. S. Eisenhower, associate director of the U. S. Office of War Information.

THE Josiah Macy Jr. Foundation, New York City, has made it possible for the National Committee for Mental Hygiene to distribute a limited number of reproductions or reprints of selected scientific articles bearing on war problems in the field of psychosomatic medicine and psychiatry to medical officers in the armed forces of the United Nations. Those who wish to receive such articles should notify the National

Committee for Mental Hygiene, 1790 Broadway, New York 19, N. Y.

IT is reported in *The Times*, London, that an official mission from the United States has recently arrived in Great Britain to discuss matters of common interest in connection with the control and production of timber and economy in its use. The mission, which was received by the Minister of Production and the Minister of Supply and officials of both Ministries, is visiting the headquarters of the Timber Control at Bristol to open discussions. Visits were also planned to the Home Timber Production Department, to timber control area offices in the provinces and to important centers of production and consumption.

Chemical and Engineering News reports that cinchona tree seeds obtained in the Philippines after the fall of Bataan provide the foundation for development of the quinine industry in the Western Hemisphere. Colonel Arthur F. Fischer, who spent many years in the Philippines raising the cinchona tree, making quinine and fighting malaria, brought 2,000,000 seeds back to the United States after his escape by plane from Mindanao. More than 100,000 seedlings, carefully nurtured by the Department of Agriculture in its experimental greenhouses, are ready for transplanting in Costa Rica. Representatives of Costa Rica and the United States have entered into an agreement under which 10,000 acres of the trees will be planted. A mission soon will leave for Costa Rica to select sites for the large-scale growing program.

DISCUSSION

CONTINENTAL DRIFT AND ANCIENT DUNES

IN 1939, von Huene proposed a method for proving or disproving the Wegener hypothesis.[1] In short, he suggested the fixing of climatic zones "for every possible stratigraphic level in every continent, if possible without gap, in order to see how they coincide." If these were to parallel the climatic zones of to-day they would argue against the drifting continent theory. If, on the other hand, the ancient climates showed an aberrant relationship to modern climatic zones, that would strengthen the Wegener hypothesis.

Von Huene suggests the distribution of gypsum as a criterion for the recognition of climatic zones. Does not the wide latitudinal range in which gypsum forms seriously lessen, if not completely eliminate, its use as such a criterion?

Evidence confined to narrow latitudinal limits is the most suitable. While engaged in field work in some of the eolian Jurassic deposits in the southwestern United States, it occurred to the writer that this type of sedimentary record, properly considered, might supply part of the evidence which, amassed in sufficient amounts, might either strongly support, or seriously question, continental drifting.

Examination of the system of planetary winds for an earth of homogeneous surface shows that under these ideal conditions six distinct wind belts are encountered in the distance between the poles. Of course, the actual wind conditions conform only in a general way to this idealized picture, because geomorphic aspects of the continents, land-sea distribution and ocean currents are not without their effects.

This general conformance of surface winds to the idealized arrangement should be reflected in the dunes formed in the larger deserts and semi-arid areas. The same should be true of ancient dune accumulations with relation to their contemporary wind belts. If the continents have always occupied their present positions and there have been no changes in the positions of the poles, then the direction of movement of ancient winds (as reflected in their deposits) should parallel in a general way the idealized wind direction arrangement. If these ancient winds are found to have blown in directions that largely disagree with the idealized wind direction arrangement as applied to the present positions of the continents, then they should conform in a general way with the earth wind system as applied to the ancient positions of the continents as suggested by Wegener and his supporters.

Cautions must be exercised in studies of this type. Only a general conformance can be looked for, and it is necessary to identify any strata used as definitely of eolian origin.

A limited amount of work has been done, though most of it deals with existing or Recent dune fields. Reiche's classic paper[2] on the Coconino sandstone of northern Arizona (of Permian age) is of a type that would prove very useful in the type of study here suggested. Among American papers dealing with more recent dune deposits, those of Hack[3] and Melton[4] should be mentioned. It is of interest to note that Reiche's and Hack's papers deal with the same general area (northern Arizona). Winds of Coconino (Permian) time blew from a roughly northerly direction. The winds producing the present dunes in this area are blowing from the southwest, and thus conform to the idealized arrangement of winds for a globe of homogeneous surface.

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[1] Friedrich von Huene, *Am. Jour. Sci.*, 237: 439, 1939.

[2] Parry Reiche, *Jour. Geol.*, 46: 905–932, 1938.

[3] John T. Hack, *Geog. Rev.*, 31: 240–263, 1941.

[4] Frank A. Melton, *Jour. Geol.*, 48: 113–174, 1940.

SOME PALEONTOLOGICAL INFERENCES AS TO THE LIFE-HABITS OF THE AUSTRALOPITHECINES

DURING the last several years the fortunate discoveries of Dr. Robert Broom have thrown considerable light upon the nature of those odd and somewhat humanoid South African primates who first came under scientific attention through the researches of Dr. Raymond Dart. Dr. Broom's finds of adult specimens have served to authenticate completely the original and much debated child fossil *Australopithecus africanus* as well as to establish the existence of more than one type of these apes. Furthermore, they apparently range over a sizable portion of Pleistocene time.

Although intense debate raged over the possible life habits of *Australopithecus africanus,* most of the discussion of the later discoveries has been purely osteological in nature, with the purposes of taxonomy in view. Hence, although Dr. Broom's final monograph has not yet appeared, some tentative suggestions as to what may be inferred in regard to the habits of these curious man-apes seem justifiable. It may serve to clarify, in some degree, the extent to which Dr. Dart's original thesis as to the terrestrial habits of these apes is capable of substantiation.

At the time of the original *africanus* discovery at the Taungs quarry, much was made of the fact that the skull had seemingly been derived from the breccia filling an old passage in the limestone cliff from which the fossil was derived. This was viewed by some as an indication that *Australopithecus,* though not a culture-producing animal, was a cave-dweller and essentially of terrestrial habits. This view has been regarded somewhat dubiously by Sir Arthur Keith[1] and others. It was suggested instead that the fossil might have become embedded along the face of the cliff, which, due to certain discharges from neighboring springs, was growing. Hence, its entombment might have been of an accidental nature. This fact, of course, would militate against acceptance of the idea that *Australopithecus* was necessarily a cave-dweller.

Broom's discovery of the new species, *Paranthropus robustus,* in a mass of breccia which had once formed the floor of a cave at Kromdraai near Sterkfontein, his location, in addition, of *Plesianthropus transvaalensis* in similar cave deposits of Middle Pleistocene age near Krugersdorp must inevitably be regarded as a well-nigh conclusive demonstration of the cave-dwelling propensities of the Australopithecines. We are forced by Dr. Broom's discoveries to contemplate the existence of ground-dwelling apes who, unlike the arboreal or semi-arboreal great apes of to-day, sought refuge among rocks and caverns. One discovery of this nature might be dismissed as accidental. Successive discoveries of similar type imply a more or less habitual use of these sources of refuge.

A number of years ago it was thought in some quarters that when our first human precursors abandoned the refuge of the trees and ventured into the plains only the most formidable, huge and aggressive species would survive the dangers of this open and cursorial existence. Now most certainly some of the human fossils such as *Meganthropus*[1a] do suggest the existence of such forms. On the other hand what do we encounter among the Australopithecines? Apes whose reduced, humanoid dentition would have frightfully handicapped them as fighters and whose size, though by no means inconsiderable, was certainly not gorilloid and which would have been of no great value in fighting off such plains-loving carnivores as the great hunting cats. The anthropoid brain capacity does not suggest that these apes had become effective tool-users, even if for the sake of argument we grant that they were capable of greater instrumental sagacity than their existing arboreal relatives. Yet seemingly they survived over a long period as terrestrial omnivorous hunters whom Dr. Broom, on the basis of certain limb fragments, believes may have been at least mainly bipedal.

The reduced canines and lack of diastemata between the two upper lateral incisors and the canines all testify to a dentition ill adapted to the crushing of tough rinds and fruits. It is a poor fighting equipment as well. Gregory, a number of years ago, expressed the view that "the conditions in which the tips of all the lower teeth are reduced to the same level and the diastemata are closed . . . is connected with . . . obvious changes in habits of feeding and of fighting. . . ."[2] We may well suspect under these circumstances, and particularly in view of Dr. Broom's insistence on the basis of an *os capitatum* referred to *Plesianthropus* that the latter had a human-like opposable thumb, that the Australopithecines had become increasingly skillful in the manipulation of food by the hands. Moreover, the reduced canines would have made the males less formidable antagonists, and it may be at least a reasonable inference that they were perhaps more socially agreeable and less combative than the males of some of the existing great apes.

It is by no means unlikely that, if the Australopithecines had indeed given up an arboreal existence for the ground, they were moving in small hordes or packs.[3] Such animal groups often have a combined

[1] "New Discoveries Relating to the Antiquity of Man," pp. 45–46. New York: W. W. Norton & Company, Inc.

[1a] F. Weidenreich, *Far Eastern Quarterly,* Nov., 1942, p. 62, 64.

[2] W. K. Gregory, "Origin and Evolution of the Human Dentition," p. 502. Baltimore, 1922.

[3] A view shared by Broom, *Nature,* 148: 10–14, 1941.

power of intimidation and "bluff" which can not be generated by a single individual or family group. Perhaps groupings of this sort, with some faint instrumental inclinations of a dim "eolithic" nature, may successfully have pursued small game and the young of larger mammals. Cliff and cave refuges may have contributed to their survival.

Their odd continuance into times late enough to have brought them in contact with more advanced and truly human forms is by no means their least interesting feature. What curious reactions must have been observable if either group ever encountered the other —the savage first men and these living fossil ancestors of the Pliocene, still apes but more human than any now alive. Was it man himself who swept them out of existence? Probably we shall never know.

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"DORMANT" VERSUS "ADVENTITIOUS" BUDS

A RECENT note by Diehl[1] on the sprouting of a staghorn sumac (*Rhus typhina* L.) log begins thus: "Sprouting of adventitious buds in logs or twigs of woody species freshly cut . . ." With no other comment concerning the origin of the sprouts in sumac, the implication is that they, too, are *adventitious*. As the species grows in New York State, however, most and perhaps all of the sprouts found on older stems have arisen from dormant buds.

It would seem profitable to restrict use of the term *dormant* or *latent* to buds formed in the axils of leaves (including scales) on the young annual shoots. These buds then persist in a dormant condition for an indefinite time with only sufficient elongation of their steles to keep the buds outside of the enveloping xylem. *Adventitious* buds, by contrast, arise outside of the normal phyllotaxy. It is recognized that adventitious buds, once formed, may also remain dormant, as is true of the root initials in the bark of willow stems. Where the origin is in doubt, or an inclusive term is desired, *epicormic* is advantageous and non-committal.

A considerable amount of unnecessary confusion has arisen from the loose or mistaken usage of the term "adventitious," particularly when the origin of the buds or sprouts in question has not been known. Foresters frequently have been at fault in this respect, but they are not alone. A popular botany text[2] makes the statement "They [adventitious buds] also give rise to the common water sprouts of apple trees and other species," although, as a matter of fact, water sprouts in apple are clearly from dormant buds.[3] Similarly, the stem sprouts of oak[4] and probably most hardwoods of the northeast,[5] as well as pitch pine[6] (*Pinus rigida* Mill.), arise in general from previously existing dormant buds, rather than adventively. In the trunk and branches of apple true adventitious buds do occur rarely in the bark but their usual origin in hardwood stems is from callus masses. A familiar example is the abundance of adventitious shoots from the callus on a cut stump of beech (*Fagus grandifolia* Ehrh.).

This question of terminology is not wholly academic. A large proportion of the northeastern hardwood forest is of sprout origin, and sprouting following thinning or pruning is of concern to both foresters and horticulturists. Reliance on literature requires that terms be specific.

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[1] W. W. Diehl, SCIENCE, 96: 2498, 448–9, November 14, 1942.
[2] J. Hill, L. Overholts and H. Popp, "Botany," p. 138. New York, 1936.
[3] V. T. Stoutemeyer, *Iowa Research Bull.*, 220: 308–52, September, 1937.
[4] E. R. Roth and B. Sleeth, *U. S. D. A. Tech. Bull.* No. 684: 4, October, 1939.
[5] M. Büsgen and E. Münch, "The Structure and Life of Forest Trees," pp. 73–74. New York, 1931.
[6] E. L. Stone, Jr., and M. H. Stone, *Am. Jour. Bot.*, 30: No. 4, 1943.

ACIDITY AND ACTIVITY OF SULFONAMIDES

RECENT work[1] has shown that a definite correlation exists between the bacteriostatic effectiveness and acid ionization constants of sulfonamides. The functional form of this relationship indicates that the drug activity is the resultant of two opposing tendencies, one of which increases effectiveness as the pK increases and the other of which decreases effectiveness. In view of the current opinion that sulfonamide activity is due to the blocking of an enzyme system,[2] it was considered advisable to examine the available data from the point of view of the general concepts of acidity[3] and the law of mass action. Interestingly enough, this fundamentally simple approach leads to qualitative and quantitative predictions which are in good accord with the available facts.

Qualitatively speaking, one would expect the compound of intermediate pK in a group of sulfonamides of widely varying pK to be most effective in producing bacteriostasis, from the following considerations. If the sulfonamide, HD, is a weak acid, then the anion, D^-, may be treated as a base. Similarly, the enzyme, or protein, P, can combine with OH^- and hence may be considered an acid. If P is an acid and D^- is a base, compounds of the type PD^- may be formed. If we assume that the activity of the drug depends on

[1] Bell and Roblin, *Jour. Am. Chem. Soc.*, 64: 2905, 1942.
[2] Woods, *Brit. Jour. Exptl. Path.*, 21: 74, 1940; Fildes, *Lancet*, 238: I, 955, 1940.
[3] Lewis, *Jour. Franklin Inst.*, 226: 293, 1938.

the amount of PD^- that is formed, and recent work[4] indicates that sulfonamide potency is a direct function of its protein-combining capacity, then in a series of drugs of various pK's acting in a solution at pH near 7, for example, those of intermediate pK should be most effective. For if the drug is a very weak acid, the number of D^- ions is very small, even though most of them may combine with the acid P to form PD^-. On the other hand, if the drug is a very strong acid, the number of D^- ions would be quite large in a solution of pH 7, but since D^- is weakly basic, little PD^- would be formed. The maximum PD^- concentration, for equal additions of sulfonamide, would be formed by a drug with some intermediate value of pK.

The same considerations apply when one considers a basic sulfonamide such as sulfaguanidine, except that in this case the neutral molecule D can combine directly with the acid P to form PD. For basic sulfonamides the same correlation should exist between pK and potency, except that pK now refers to the equilibrium $HD^+ = H^+ + D$.

This qualitative description is supported fully by a detailed, quantitative consideration of the equilibria involved. Complete details of this treatment will be given in a forthcoming publication. For the present it will be sufficient to point out that the equations finally reduce to the following condition relating the pK of the sulfonamide of maximum activity to the pH of the solution:

$$pK_{HD} = pH - \log \frac{1-f}{f} \qquad (1)$$

where

$$f = \frac{d \ln K_{PD}}{d \ln K_{HD}}, \qquad (2)$$

K_{PD} being the dissociation constant of the enzyme-sulfonamide complex. When f is determined for a given bacterial system, pK_{HD} can be predicted immediately.

Unfortunately we can not make a direct test of this prediction at present, because data for the direct evaluation of f for bacteria are unavailable. Nevertheless, we can evaluate f indirectly for *E. coli* and compare the value so obtained with that derivable from work[4] on the combination of serum albumin with sulfonamides.

Bell and Roblin[1] have found that in a solution of pH 7, maximum bacteriostasis of *E. coli* was obtained with a sulfonamide with a pK of about 6.7. Substituting the appropriate values in (1) we find f is 0.3. Such a value of f is apparently very reasonable if we may compare it with the approximate value derived for serum albumin. From the work of Davis and Wood[4] one can calculate relative values of K_{PD}, for sulfonamides of various K_{HD}'s. A plot of log K_{PD} vs. log (K_{HD}) fits a straight line fairly well and the slope of this line is f. For serum albumin f turns out to be 0.5.

The inhibition of sulfa action by p-aminobenzoic acid is also amenable to the type of treatment described above. In this case we assume that when the ratio of PA^- (the p.a.b.-enzyme combination) to PD^- reaches some fixed value, inhibition sets in. The mass law treatment then predicts that the ratio of the total amount of p-aminobenzoic acid necessary to cause inhibition, to the total amount of sulfonamide present, will be a maximum for the sulfa compound of greatest potency. This is in agreement with the data of Rose and Fox.[5]

Thus, the law of mass action, as applied to a system consisting of a sulfonamide and an enzyme in a buffer solution, predicts the existence and acid dissociation constant of a drug of maximum potency, correlates the effectiveness of basic as well as acid sulfa compounds with their acid ionization constants, and accounts quantitatively for the inhibitory effect of p-aminobenzoic acid.

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CORRECTION

IN a revision of the proof a serious omission was made in the inadvertent dropping of "and 1 ml. of 0.1% $CuSO_4 \cdot 5H_2O$ solution" after "Aliquots of 2.0 ml are mixed with 6 ml of clear 12.5 per cent Na_2CO_3 solution" on p. 405. Addition of copper is essential in enhancing the sensitivity of the Folin reagent, as already noted by others.

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SCIENTIFIC BOOKS

PHYSIOLOGICAL CHEMISTRY

The Dynamic State of Body Constituents. By R. SCHOENHEIMER. Harvard University Monograph in Medicine and Public Health No. 3. 79 pp. Harvard University Press. 1942. $1.75.

THE nineteenth century, which ended about 1914, was the callow age of the physiological chemist. Rudolph Schoenheimer's "The Dynamic State of Body Constituents" marks the transition to a humbler, more realistic and more mature state of mind.

Until recently, the physiological chemist described

[4] Davis, SCIENCE, 95: 78, 1942; Davis and Wood, *Proc. Soc. Exptl. Biol. Med.*, 51: 283, 1942.

[5] Rose and Fox, SCIENCE, 95: 412, 1942.

the animal organism as an engine with a relatively static structure, in which the food was the fuel. A small fraction of the food was used to replace the wear and tear losses of the engine's structure. The working parts of the engine were composed of what was called "protoplasm."

This concept was typical of the era in which thermodynamics with its satellite Newtonian statistical mechanics reigned as the newly enthroned queen of the physical and chemical sciences. It was the era of combustion engines, the era of Helmholz.

The simplicity of the concept of the organism as a combustion engine was, no doubt, one of its attractions. Another was that it helped the physiologists and physicians who were its devotees to feel respectable in the company of the chemists and especially the physicists who were the rigorous, pukka natural philosophers of the nineteenth century.

The concept of the organism as a machine was not a biological concept at all. The physiological chemist knew, or should have known, better. Bernard had demonstrated that the different forms of carbohydrate are maintained *in vivo* in a dynamic steady state and that so long as the animal is alive this steady state can oscillate between only very narrow boundaries. Bernard amplified and generalized the idea into his great concept—"La fixité du milieu intérieur est la condition de la vie libre." Bernard saw clearly, although he had only few examples, that the constancy of the internal environment was a dynamic steady state, and that its constancy was an essential condition of life and was maintained against the impact of wide variations in the external environment.

Outside his laboratory the physiological chemist got himself befuddled by the siren concept of "protoplasm." He knew it is not a substance at all but a conglomerate of many substances; and the idea told him nothing of functional organization. But nevertheless he accepted "protoplasm" as the structural substance of the living combustion engine; the definitive and essential component of "protoplasm" was, of course, protein. This must have been one of the reasons for the welcome which Folin's theory of protein metabolism (first published in 1905) received, and the tenacity with which it has been retained until very recently in the face of accumulating evidence to the contrary over the last thirty years.

According to Folin's theory, the structural parts of the animal body are subject to a continual but small wear and tear and repair. Since the terms "structural," "mechanical" and "protein" were used almost as if they were synonyms, the sum total of changes involved in this wear and tear and its repair was designated "endogenous" protein metabolism. Because the organism was viewed as an engine, and because the structural substance of an engine wears away only very slowly, it followed that only a small fraction of the protein in the food is needed for "endogenous" metabolism. The remainder of the protein in the food, the bulk of it, is quickly hydrolyzed and burned and the fragments excreted. This moiety was designated "exogenous" protein metabolism. Folin's theory was useful; it was based on data which he was the first to obtain, by methods which he had devised or greatly improved. But these data, it is now proved, were misinterpreted, they were forced into the strait-jacket concept of the organism as a combustion engine.

Fat metabolism was viewed in the same context. The bulk of the fat in the body was a depot of storage material, a reserve of energy. This depot was thought to be nearly inert, drawn on only in time of need. Here also there was conflicting evidence, but for the same reasons as in the case of protein metabolism this evidence was ignored.

Schoenheimer and his colleagues at Columbia obtained direct evidence "that all constituents of living matter, whether functional or structural, of simple or complex constitution, are in a steady state of rapid flux." It should be added that the studies of the Schoenheimer group did not deal with carbohydrate metabolism, to which this generalization also applies. Their findings were summarized by Schoenheimer in his 1941 Dunham lectures, and published in this book. The manuscript was prepared for publication after Schoenheimer's untimely death by Dr. Hans T. Clarke and his colleagues.

All these experiments were "tracer" studies. A substance was "marked" with a stable isotope, deuterium, or N_{15}, or both, fed to an animal, and then, from the concentration of the isotope in different body constituents conclusions could be drawn regarding the chemical changes undergone *in vivo* by the substance into whose structure the isotope in question had been incorporated.

Thus with deuterium as a "tracer," it was shown that the fats of the depots are not inert storage materials but that "the fatty acids of the depot fat are to be regarded as being constantly transported, in the form of fats or phosphatides, to and from the organs, where fatty acids are temporarily liberated by rupture of ester linkages. When fat is absorbed, the acids of dietary origin merge with those from the depot, thereby forming a mixture indistinguishable as to origin. Part of the liberated acids are converted into others, whole new ones are steadily formed by condensation of small molecules derived from other substances. Some of this pool of acids is degraded, and

some of it re-enters ester linkages to regenerate fat, which is transported back to the depots. All these complex reactions are so balanced that the total amount and structure of the fat mixture in depot, blood and organs remain constant."

The metabolism of phospholipids deserves a fuller treatment than they are given in this book, especially as we are indebted to isotope studies for nearly all the new and important information on this difficult subject. There is only a cursory sketch of the intensely rapid processes in which the phospholipids are fragmented into their fatty acid, phosphate and choline or ethanolamine components and as rapidly resynthesized.

Essentially the same general picture was obtained of protein metabolism. Here N_{15} was the tracer most commonly used. It was demonstrated that amino acids are continually and rapidly being deaminized and reaminated. Free ammonia is extensively used for reamination. The peptide bonds of the protein chains are similarly continually being broken and reformed. Synthesis of amino acids and protein occurs both when these are abundantly supplied in the diet and when the animal is made to lose weight through inadequate nitrogen in the diet.

It has been argued by die-hard adherents of the older theory that only the so-called "reserve" or "fixed" proteins undergo this rapid disintegration and re-synthesis. Against this argument it was shown that proteins with specific functions, specific antibody proteins, for example, undergo the same rapid synthesis and disintegration as the average immunologically inert serum proteins. Recently it was proved that extensive and rapid resynthesis of protein is continually in progress even in the fasting animal. This and other evidence has destroyed the last vestiges of support of Folin's theory of "endogenous" and "exogenous" protein metabolism.

The important contribution of these studies with isotopes is that they provided direct and incontrovertible evidence for the concept of the organism as a dynamic steady state in which, for the time being at any rate, there is little utility in attempting to distinguish between the chemical changes in the structure of the engine and its fuel. Structural substance and fuel substance are continually interchanging on a large scale and very rapidly.

It is a disservice, however, to the classical pre-isotope methods of physiological chemistry to overlook, as many workers with isotopes and others do, that this concept regarding the proteins in the animal body was enunciated explicitly with a wide variety of supporting evidence before the advent of isotopes.

This criticism applies also to the claims made for the information gained regarding the formation of a variety of amino acids from each other and of urea and creatine. The isotope studies, in most instances, provided only corroborative evidence of facts which had already been firmly established and in more detail by other methods.

In fact, isotope studies have yielded little evidence regarding mechanism. In the two cases they have thrown light on mechanism, the formation of creatine and the transfer of methionine sulfur to form cystine, the same facts were established by direct evidence and in more detail, independently and contemporaneously by non-isotope methods. The latter methods also located the organs in which these changes occur.

The conclusions regarding the dynamic state of body constituents are stated in this book lucidly and eloquently. These ideas are so important that we must regret the book is too short mainly because it is a one-sided account even of the isotope evidence. A broader treatment including earlier non-isotope studies would have shown, on the one hand, more clearly the power of the new tool the physiological chemist has acquired in his use of isotopes and, on the other, the great utility and wide range of the concept of the organism as a dynamic steady state. In contrast to the mechanical nineteenth century concept it has replaced, the new concept is biological. It explains, without strain, the inter-relation between the metabolism of carbohydrate, phosphate and protein, the regeneration of plasma protein, certain aspects of the formation and disappearance of antibodies from the blood, the changing size of organs and muscles in different dietary states. The new concept has given us a view of the organism as a chemical system in which protein, fat, carbohydrate, minerals, vitamins and water are continually and rapidly interacting and yet maintain "la fixité du milieu intérieur" which is "la condition de la vie libre." Our former obscure wonder is replaced by a greater and informed humility and even greater admiration of the marvelous coordination of the complex chemical mechanisms by which living matter sustains itself.

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MODERN PHYSICS

Introduction to Modern Physics. By F. K. RICHTMYER and E. H. KENNARD. Third edition. xv + 723 pp. 234 figures. New York and London: McGraw-Hill Book Company. 1942. $5.00.

THE late Professor Richtmyer's deservedly popular text on modern physics needs no introduction to the reading public. The progress of modern physics has been so rapid during the fifteen years since the first edition was published, however, that frequent revi-

sions of a book of this character have been necessary in order to keep it up-to-date. Thus a second edition was issued in 1934, and now a thoroughly revised third edition has been prepared by Professor Richtmyer's colleague, Professor Kennard, with the assistance of several of his associates on the Cornell University faculty.

The large amount of new material which had to be included if the text was to live up to its title, raised the difficult question of what to leave out. This matter has been admirably handled by Professor Kennard on the general principle that those topics in classical physics which are adequately treated in available general texts might well be skeletonized to the parts essential for future reference or omitted entirely. Thus the historical introduction has been abbreviated from 77 pages in the first edition to 50 pages, and the chapter on electromagnetism has been confined to those topics which are requisite for the subsequent developments and which are not usually contained in general texts. A short chapter on relativity has been added, but the greater part of the book is devoted to quantum phenomena, their description and their explanation. The chapter on x-rays has been completely revised, that on nuclear phenomena greatly extended, and a new chapter on cosmic-rays has been added.

In spite of these extensive revisions the character of the book has remained true to the standards set by Professor Richtmyer in the original edition. No attempt is made to give a logically complete development of modern theoretical physics. Rather the reader's attention is focussed on the phenomena of modern physics and on the understanding of modern concepts. Simple derivations of theory—often only for special cases—are given, but all complicated analyses are omitted. In this way the reader is led rapidly to the forefront of modern physics without having his attention distracted by mathematical details, which his awakened interest may lead him to fill in at a later time.

The book is designed as a textbook rather than as a treatise or a reference work. The large number of diagrams and photographic reproductions and the excellent printing add greatly to its usefulness. It is safe to predict that this revision will be welcomed with the same enthusiasm which greeted the earlier editions.

LEIGH PAGE

SPECIAL ARTICLES

DEMONSTRATING THE PRESENCE OF SULFONAMIDES IN THE TISSUES[1]

A PREVIOUS communication[2] reported the development of new vehicles (penetrasols) which increased the penetration of a large variety of substances through grossly intact skin (for example, protein allergens, iron, mercury, bismuth and the sulfonamides). One of the methods used to demonstrate the penetration of sulfonamides into and through the skin was excision of the area of inunction and the use of a newly developed histochemical technique, which produces a color reaction with sulfonamide in the tissues. We herewith report the details of this new method, since we believe that it may find many general applications.

I. ANESTHESIA AND EXCISION

Before excising the skin, general ether anesthesia was used in the guinea pigs; and local procain anesthesia in the human subjects. In the latter, the procain solution was injected around and well away from the site of the sulfonamide inunction and eventual biopsy. This is an indispensable precaution, as the presence of injected procain solution, or even fluid alone, could produce erroneous results. The line of excision was made outside and at considerable distance from the site of inunction, in order to avoid displacement of the inunction-material with the scalpel.

II. FIXATION

The usual liquid fixatives can not be employed, as the sulfonamides might be washed out or displaced by the liquid. Dry formaldehyde *gas* was therefore chosen as the fixative. Paraformaldehyde (trioxymethylene) powder is spread over the floors of small glass beakers. These beakers are roofed either with a piece of gauze fixed by a rubber band or by a small glass lattice. The biopsy specimens are spread flatly on these sieves. The small beakers are then placed in a larger glass jar, the floor of which has also been covered with a layer of paraformaldehyde powder. The top of the jar is closed with a well-fitting glass cover. The large jar containing the smaller beakers is kept tightly closed throughout the period of fixation by means of several windings of adhesive tape around the line of closure. (The layer of paraformaldehyde powder on the floor of the small beakers and of the larger jar should be about 1 cc in depth.)

At room temperature, fixation takes place in two to twenty-four hours, depending on the size and thickness of the specimens.

Microtome cutting is best carried out immediately after fixation; but we have, on occasion, obtained

[1] This research was made possible by a grant from the Wallace Laboratories, Inc., New Brunswick, N. J.

[2] Herrmann, Sulzberger and Baer, SCIENCE, 96: 451, 1942.

good sections as long as ten to fourteen days after fixation, despite some visible shrinkage and discoloration of the gross specimen.

III. CUTTING

Frozen sections of 10 μ to 20 μ (average 16 μ) are cut with care to prevent the microtome knife from displacing the sulfonamide. The specimen should be kept in such a position on the freezing table that the epidermal surface is never directed toward the knife, but always toward the operator. (The tendency of the thin epidermis of animal skin to separate as a thin lamella before the cutting knife can be overcome by placing the specimen sagittally, at an angle of 90 degrees to the edge of the knife.)

IV. CHEMICAL REAGENTS AND PROCESS

After trial of many standard reagents and solutions for demonstrating sulfonamides, we found that for our purposes the most suitable reagent and solution was Ehrlich's reagent, *i.e.*, p-dimethylaminobenzaldehyde, as used by A. E. A. Werner[3] and others for quantitative analyses of sulfonamides in biologic fluids. The optimal reactions were obtained with the following solution:

P-dimethylaminobenzaldehyde	1.0 g (grams)
Absolute alcohol	95.0 cc
Concentrated HCl	5.0 cc

The aldehyde must be as pure as obtainable, with little color or, at most, a light buff shade. Freshly prepared solutions are best, but a solution not over two or three weeks old may suffice, if it has been kept in ground-glass-stoppered, amber-colored flasks.

The frozen sections, obtained in the manner described, are placed directly on a clean slide, by means of a dry camel's-hair brush. Two drops of the above p-dimethylaminobenzaldehyde solution are dropped on the section. After three to five minutes, one to two drops of absolute alcohol containing 5 per cent. concentrated HCl are added. From this point on the procedure must be carried out as quickly as possible. The sections are dried by careful absorption of excess fluid with small pieces of filter paper or before a slowly rotating fan or both. (Warming is not advisable.) When dry, the sections are covered with a high concentration of dammar resin in xylene, as follows:

Dammar resin	10.0 g
Xylene	10.0 g

The cover slip is then superimposed. Air bubbles under the cover slip must be removed; then the edges are sealed with liquid paraffin melting at 56° C.

[3] A. E. A. Werner, *Lancet*, 136: 18, 1939.

This method demonstrates the sulfonamide in the tissues as a colored precipitate, ranging from lemon-yellow to orange, depending on the concentration of the drug.

This colored reaction-product bleaches out, particularly rapidly in the presence of air. Even with all precautions to expel air bubbles, with the thick dammar resin employed and with the paraffin sealing of the edges, microscopic examinations and microphotographs should be made as early as posible, and never more than three to four hours after the reaction has occurred.

V. CONTROLS

Several controls are indicated in order to make sure that the yellow to orange color is actually due to a chemical reaction between the sulfonamides and the reagent, and not due to artefacts or to the presence of preformed yellowish or orange material. These controls include:

(1) Examination of sections of tissue which has been exposed to sulfonamide, using all the procedures outlined, with the exception of the treatment with the p-dimethylaminobenzaldehyde solution.

(2) Examination of sections of tissue which has not received sulfonamide inunction and which is known to be free of sulfonamide; or, in the case of systemic administration of the drug, of tissue from the corresponding organ of an individual who has not received the drug. These sections are, of course, to be processed and treated in exactly the same way as the specimen being investigated for presence of sulfonamides, including treatment with the solution of p-dimethylaminobenzaldehyde.

Comparative examination of these control sections and the section being investigated will reveal the presence or absence of (a) preformed colored material and (b) material other than sulfonamide which might give similarly colored reaction-products with p-dimethylaminobenzaldehyde (primary aromatic amines, urobilinogen, urea, etc.).

Our studies indicate that the method just described will be of value in defining the presence, route and localization of sulfonamides in many different tissues (for example, skin, urethra, other mucous membranes, tonsils, bone marrow, etc.); but is not likely to be useful in tissues such as those of the liver, gall bladder, etc. Of course, the localization of the colored material and the intensity of the color can be expected to give only indications of quantity and site, rather than absolute values.

Nevertheless, employing this method in our studies of percutaneous absorption of locally applied sulfonamides in various penetrasol-type vehicles, we have been able to demonstrate that certain of these vehicles favor the concentration of the drug in horny and follicular structures, while others permit penetration

and more or less equal distribution through all the cutaneous tissues. Details of these studies on different types of skin-penetrating vehicles, as well as further discussion of the histochemical method itself, will be published shortly.[4]

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ETHER AND METABOLISM IN THE CEREBRAL CORTEX[1]

JOWETT and Quastel[2] have concluded that anesthetic concentrations of ether do not inhibit by more than the experimental error the respiration of the gray matter of the cerebral cortex of the rat or guinea pig. That another metabolic process might be affected by ether was suggested by an observation made on slices of cerebral cortex from cats under ether anesthesia.[3] Measured in phosphate medium, the lactic acid output was greater in slices from these animals than from controls. The present report is concerned with the effect of ether applied *in vitro* on the oxygen uptake and lactic acid output by cat cerebral cortex slices.

The procedure was as follows. First, the oxygen uptake in Ringer-phosphate-glucose medium in six vessels with oxygen in the gas phase, was observed for 45 minutes. Second, a quantity of medium with or without ethyl ether dissolved in concentrations up to 40 mg per cc was added to each vessel through the venting plug by means of a syringe fitted with a long needle, to make a final concentration of up to 9 mg per cc. Third, oxygen uptake was followed for from two to six hours more. The details of the manometric technique were as reported elsewhere[4] except that the shaker speed was 80 cycles per minute. Fourth, metabolism was stopped by tipping in HCl solution from the side arm, and the concentration of ether in the medium was estimated manometrically with a temperature change of 1.5° by the method of Jowett.[5] Fifth, the lactic acid that accumulated in each vessel was determined by the method of Barker and Summerson.[6] In the control vessels the lactic acid content was higher at the end of the experiment than at the end of the first 45 minutes.

Data for 15 cats and the standard errors of the means are given in Table 1, in four groups according to ether concentration. In the first group the concentration was such that it would not produce unconsciousness if present in the blood.[7] In the second group the ether concentration would produce full anesthesia. The higher concentrations would be lethal. Oxygen uptake is recorded as a percentage of the initial rate for each vessel corrected for any change in rate with time in the control vessel, to which an addition of medium without ether had been made. Lactic acid is reported as the difference between the amounts in the vessel containing ether and in the control vessel, divided by the number of hours of exposure to ether.

TABLE 1

EFFECT OF ETHER ON THE OXYGEN UPTAKE AND LACTIC ACID OUTPUT BY SLICES OF CEREBRAL CORTEX OF THE CAT IN RINGER-PHOSPHATE-GLUCOSE MEDIUM

Ether concentration			Oxygen uptake						Extra lactic acid output
Range	Mean		1st hour		2nd hour		3rd hour		
mg/cc	mg/cc	M × 1000	c.*/o.	Per cent. of control	c.*/o.	Per cent. of control	c.*/o.	Per cent. of control	c.*/o. mg/g/hr
0.025–0.4	0.2	2.7	6/14	97 ± 1.85	6/14	95 ± 2.09	3/3	90 ± 6.46	6/14 4 ± 0.93
0.7 –1.6	1.3	17.5	9/15	100 ± 1.34	9/15	101 ± 1.29	5/11	100 ± 2.00	9/15 3 ± 1.19
2.0 –5.3	3.7	50	7/14	103 ± 1.73	7/14	106 ± 1.89	5/8	111 ± 3.63	7/14 5 ± 0.62
6.7 –9.6	8.4	113	6/9	107 ± 6.1	6/9	86 ± 8.8	6/9	43 ± 6.9	6/9 14 ± 2.75

* Number of cats/number of vessels.

[4] MacKee, Herrmann, Baer and Sulzberger, *Jour. Clin. and Lab. Med.*, 1943 (in press).

[1] Aided by a grant from the Milton Fund of Harvard University to Henry K. Beecher.

[2] M. Jowett and J. H. Quastel, *Biochem. Jour.*, 31: 1101, 1937.

[3] H. K. Beecher and F. N. Craig, *Jour. Biol. Chem.*, 148: 383, 1943.

[4] F. N. Craig and H. K. Beecher, *Jour. Neurophysiol.*, 6: 135, 1943.

[5] M. Jowett, *Biochem. Jour.*, 31: 1097, 1937.

[6] S. B. Barker and W. H. Summerson, *Jour. Biol. Chem.*, 138: 535, 1941.

[7] H. W. Haggard, *Jour. Biol. Chem.*, 59: 783, 1924.

The observation that ether in sub-lethal concentrations had no effect on oxygen uptake confirms the results of Jowett and Quastel. With regard to the hypothesis that ether acts as an anesthetic agent because of an inhibitory influence on oxidations in the central nervous system, the evidence from the rat, guinea pig and cat is considered strongly negative.

With even the lowest concentrations of ether there was a small but significant increase in lactic acid output. This appeared to be a unitary phenomenon, for, as the concentration of ether was raised, the extra lactic acid did not change appreciably until a definite inhibition of oxygen uptake occurred. The increase in lactic acid output by low concentrations of ether was small compared with that produced by cation imbalance[8,9] and by various dyes.[10] Since it appears with concentrations found in blood during light as well as deep anesthesia, the effect may be of interest in theoretical considerations of the mechanism of action of ether in anesthesia.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

LARGE-SCALE PRODUCTION OF PENICILLIN[1]

LARGE-SCALE production of penicillin is hampered by the necessity of: (1) providing a surface area exposed to the air of approximately 500 sq cm per liter of culture medium and of (2) growing the organism, *Penicillium notatum*, for 5 to 8 days under such conditions. Consequently, the production of large quantities of penicillin requires the use of a large number of culture vessels over a period of time. The idea occurred to the author that the fungus might grow well and produce penicillin continuously in a constant flow of medium trickling over a column of wood shavings in a setup similar to that commonly employed in the "quick" or "generator" process for the production of vinegar from wine or cider by the acetic acid bacteria. In the acetic acid generators a relatively large surface area per unit of volume is exposed to freely circulating air and medium with the result that the acid is produced rapidly and in quantity. The following experiments were designed on a laboratory scale to determine the feasibility of producing penicillin under conditions similar to those prevailing in vinegar generators.

The experimental apparatus consists of a glass tube 4 feet long and 2 inches in diameter containing a 3-foot column of wood shavings supported on a 4-inch layer of larger pieces of wood. In the original apparatus a stream of air was circulated upward through the column, but as the shavings were rather fine, the organism tended in time to block the upward passage of air as well as the downward flow of medium. It was found, however, that this can be prevented by the use of large shavings and a looser packing of the column. A downward flow of air also proved satisfactory.

In the present arrangement, the top of the tube is closed with a two-holed rubber stopper carrying: (1) a glass tube for the entrance of air filtered through a column of sterilized cotton and (2) a thick-walled capillary tube drawn out to a fine point for the delivery of the culture medium. From a large flask supported above the column, the fresh medium flows through a siphon connected to the capillary tube, which delivers it drop by drop on top of the column of wood shavings. The rate of flow is controlled by the diameter of the capillary tip and also by a pinchcock on the rubber tubing connecting the capillary tube to the reservoir of medium. The bottom of the glass column is closed with a one-holed rubber stopper fitted with a glass exit tube which allows the escape of air as well as of medium. This exit tube is connected by means of a piece of rubber tubing to a collecting flask equipped with a two-holed rubber stopper through which passes: (1) a tube for the liquid and air to enter the flask and (2) an air exit tube connected to the suction line. Medium, rubber tubing and collecting flasks are sterilized in the autoclave and fitted aseptically to the appropriate tubes of the culture apparatus. The latter, packed with wood shavings and with stoppers in place, is sterilized by allowing steam to flow through it for two hours.

Three culture columns as described above are now in operation. One of these columns consists of two such tubes in series and is used to determine the effect of doubling the length of the culture column. All studies were carried out in a 26° C. constant temperature room.

After the columns are sterilized and the medium reservoir and collecting vessels attached thereto, the shavings are well wetted with culture medium and

[1] Aided in part by the Fluid Research Fund, Stanford University School of Medicine.

[8] C. A. Ashford and K. C. Dixon, *Biochem. Jour.*, 29: 157, 1935.

[9] F. Dickens and G. D. Greville, *Biochem. Jour.*, 29: 1468, 1935.

[10] F. Dickens, *Biochem. Jour.*, 30: 1233, 1936.

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inoculated with a spore suspension of *P. notatum*.[2] Czapek-Dox medium (Florey et al.[3]) containing 4 per cent. glucose and 0.1 per cent. Difco yeast extract was employed. A continuous flow of the medium is started 24 hours after the inoculation and growth of the fungus usually becomes well established by the 5th day. In one of the columns the medium was allowed to collect and was drained off daily instead of continuously. In this case there was a marked inhibition of growth, even with vigorous aeration. This column was, therefore, converted after several days to continuous flow arrangement. Ordinary surface cultures of *P. notatum* in the same medium served as controls for comparative purposes on the amount of penicillin produced.

The rate of flow of medium has been varied from 400 to 1,000 ml daily and the sugar content from 1 to 4 per cent. with little influence on penicillin titer. After growth is well established, yeast extract does not appear to be essential for penicillin production, but a 4 per cent. concentration of sugar may be of some value inasmuch as all but a fraction of a mgm of sugar per ml is utilized during the flow of the medium through the growth column.

One column has been in satisfactory operation and free from bacterial contamination for 15 days. The rate of flow of the medium through this column has varied from 600 to 800 ml daily and the effluent has had a pH of 7.0–7.3. Serial dilutions in broth of the penicillin-containing effluent were inoculated with *Staphylococcus aureus*. Growth in the various dilutions following 20 hours incubation at 37° C. was compared with that of a control culture of *S. aureus* and with serial dilutions tests on ordinary surface cultures of *P. notatum*. Typical results are presented in Table 1.

TABLE 1

PENICILLIN TITER IN CONSTANT FLOW AND ORDINARY CULTURES OF PENICILLIUM NOTATUM

Fluid from	Age of culture in days	Dilutions				
		1–10	1–20	1–40	1–80	1–160
Constant flow apparatus	5	–	–	–	‡	+
	10	–	–	–	–	+
	15	–	–	–	‡	+
Ordinary culture, maximum titer	6	–	–	–	–	+

– no growth, ‡ slight growth, + full growth of *S. aureus*.

It is apparent that the penicillin titer of the effluent from the constant flow apparatus approaches that observed with the fluid from ordinary surface cultures of *P. notatum*. Only one strain of *P. notatum* and one medium has been thoroughly tested thus far. Higher titers might well be obtained with other strains of the fungus or in other media. In incomplete studies the substitution of corn steep liquor in place of yeast extract more than doubled the amounts of penicillin produced. The constant flow method appears to have the advantage that once growth of the organism is well established, penicillin is produced continuously and a large volume of penicillin-containing liquid can be obtained with a minimum of equipment in a short period of time.

Doubling the length of column by connecting two tubes in series appears to increase the penicillin concentration in the effluent to a slight extent. Some difficulty was experienced in obtaining satisfactory growth in the second column due to the rapid depletion of the culture medium. Therefore, the influence of an increased rate of flow of a more concentrated medium was tested, but bacterial contamination was encountered before entirely conclusive results could be obtained.

Further studies on factors influencing the production of penicillin in a flow of medium continuously trickling in a thin stream over the fungus growing on a column of shavings are in progress. The prevention of bacterial contamination appears to be the most difficult, but not insurmountable, obstacle to the production of penicillin on a large scale. The apparatus employed in this study may also prove satisfactory for the growth of other aerobic organisms producing antibiotic agents. The results of these preliminary studies suggest that a fairly high penicillin titer can be obtained under the conditions described and that penicillin may be produced rapidly and in large quantities in acetic acid generators.

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[2] The culture of *P. notatum*, from the original Fleming strain, was provided through the courtesy of the Cutter Laboratories, Berkeley, Calif.

[3] E. P. Abraham, E. Chain, C. M. Fletcher, H. D. Gardner, N. G. Wheatley, M. A. Jennings and H. W. Florey, *Lancet*, 241: 177–88, 1941.

BOOKS RECEIVED

Essays in Biology. In Honor of Herbert M. Evans. Illustrated. Pp. xxxi + 684. University of California Press. $10.00.

DUBLIN, LOUIS I. *A Family of Thirty Million.* Illustrated. Pp. xvi + 496. Metropolitan Life Insurance Company.

LUCK, JAMES MURRAY. *Annual Review of Biochemistry.* Illustrated. Pp. ix + 704. Annual Reviews, Inc. $5.00

MURRAY, RAYMOND W. *Man's Unknown Ancestors.* Illustrated. Pp. xiii + 384. The Bruce Publishing Company. $3.50.

RAVEN, C. E. *Science, Religion, and the Future.* Pp. x + 125. The Macmillan Company. $2.00.

SMITH, H. T. U. *Aerial Photographs and Their Applications.* Illustrated. Pp. xiv + 372. D. Appleton-Century. $3.75.

WHITE, MARSH W. *Practical Physics.* Illustrated. Pp. x + 365. McGraw-Hill. $2.50.